



UNITED STATES
DEPARTMENT OF THE INTERIOR

DRAFT
ENVIRONMENTAL STATEMENT

DES 73-1

Proposed
1973 OUTER CONTINENTAL SHELF
EAST TEXAS GENERAL
OIL AND GAS LEASE SALE

PROPERTY OF
Bureau of Land Management
DSC LIBRARY



Prepared by
BUREAU OF LAND MANAGEMENT
U. S. DEPARTMENT OF THE INTERIOR

Bureau of Land Management
Library
Denver Service Center

BLM Library
Denver Federal Center
Bldg. 50, OC-521
P.O. Box 25047
Denver, CO 80225

Summary

(X) Draft () Final Environmental Statement
Department of the Interior, Bureau of Land Management
Division of Marine Minerals

1. Proposed Oil and Gas Lease Sale, Outer Continental Shelf, Gulf of Mexico.
(X) Administrative () Legislative Action
2. One hundred twenty-nine tracts (697,643 acres) of OCS lands are proposed for leasing action. The tracts are located off-shore Texas. If implemented, this sale is tentatively scheduled to be held in late spring, 1973.
3. All tracts offered pose some degree of pollution risk to the environment and adjacent shoreline. The risk potential is related to adverse effects on the environment and other resource uses which may result from accidental or chronic oil spillage. Each tract offered is subjected to a matrix analytical technique in order to evaluate significant environmental impacts should leasing and subsequent oil and gas exploration and production ensue.
4. Alternatives considered:
 - A. Hold the Sale in Modified Form
 - B. Withdraw the Sale
 - 1) increased oil imports
 - 2) increased onshore oil and gas production
 - 3) increased nuclear power
 - 4) increased use of coal
 - 5) increased hydroelectric power
 - 6) modification of FPC natural gas pricing
 - 7) oil shale production
 - 8) wellbore stimulation for recovery from known deposits
 - 9) increase LNG imports
 - 10) synthetic natural gas and oil
 - 11) energy conservation
 - 12) combinations of alternatives
 - C. Delay Sale

PROPERTY OF
Bureau of Land Management
D S C LIBRARY

5. Comments have been requested from the following:

Environmental Protection Agency

Department of Commerce

National Oceanic and Atmospheric Administration

Department of Transportation

U. S. Coast Guard

Atomic Energy Commission

Federal Power Commission

Office of Emergency Preparedness

Council of Economic Advisors

State of Florida

Department of Administration

State of Louisiana

Commission on Intergovernmental Relations

Department of Conservation

Louisiana Wildlife and Fisheries Commission

State of Alabama

Alabama Development Office

State of Mississippi

Coordinator for Federal-State Programs

State of Texas

Office of the Governor

Department of the Interior

Bureau of Sport Fisheries and Wildlife

Bureau of Outdoor Recreation

Bureau of Mines

Geological Survey

National Park Service

Office of Oil and Gas

6. Draft statement made available to the Council on Environmental Quality and the public on January 18, 1973.

TABLE OF CONTENTS

I. DESCRIPTION OF THE PROPOSAL

	Page
A. Background of Proposal.	1
B. Tentative Five-Year Schedule.	3
C. Activity, Environment, and Impact from the Five-Year Schedule in the Gulf of Mexico. . .	7
1. Proposed Sales.	7
2. Development	7
3. Environment	9
4. Resource Use and Commercial Activity Related to the OCS in the Gulf of Mexico	14
5. Possible Environmental Impacts from OCS Oil and Gas Development Resulting from Implementation of the Five-Year Lease Schedule	22
D. Location and Reserves	25
E. Tract Selection	27
1. Responsibilities and Procedures	27
2. Purpose of the Tract Selection Process.	29

II. DESCRIPTION OF THE ENVIRONMENT

A. Geologic Framework: Geologic History and Physiography	31
1. Origin of the Gulf of Mexico.	31
2. The Continental Shelf	33
3. Coastal Louisiana	44
4. Coastal Texas	45
B. The Climate of Coastal Texas and Louisiana, and Adjacent Gulf Waters	50
1. General Climatology and Seasonal Weather Patterns	50
2. Sky Cover and Visibility - Seasonal Variations. .	54
3. Surface Wind Patterns	56
4. Surface Air Temperatures.	60
5. Precipitation	61
6. Severe Storms	61
C. Physical Oceanography	67
1. Sea Surface Temperatures.	67

	Page
2. Salinity.	67
3. Ocean Currents.	71
4. Astronomical Tides.	75
5. Ocean Wind Waves (Sea) and Swell.	79
D. Ecology of the Northwestern Gulf of Mexico and Adjacent Coastal Zone.	82
1. The Coastal Zone.	82
2. The Continental Shelf and Neritic Waters. . .	116
3. The Oceanic Region - The Deep Gulf.	125
E. Resources of the Northwestern Gulf of Mexico and Adjacent Coastal Zone.	128
1. Land Use Patterns and Resources of the Coastal Zone	128
2. Commercial Fisheries of the Northwestern Gulf of Mexico	153
3. Sport Fishery in the Western Gulf of Mexico .	161
4. Oil and Gas Resources	163
Bibliography.	164

III. ENVIRONMENTAL IMPACT OF THE PROPOSED SALE

A. Introduction.	170
B. Exploration and Construction Phase.	170
1. Seismic Exploration	170
2. Exploratory Drilling.	176
3. Construction of Permanent Platforms and Pipelines.	206
C. Production Phase.	224
1. Production Well Drilling.	224
2. Production Well Workover, Platform Maintenance and Repair Work	228
3. New Production Operations	230
4. Chronic, Low-Level Oil Spillage	240
D. Termination of Oil and Gas Operations	245

E. Frequency of Occurrence of Impact-Producing Events and Significant Accidents Related to Offshore Oil and Gas	246
1. Natural Gas Leaks Associated with Blowouts	247
2. Major Oil Spills	247
3. Minor Spills	249
4. Collisions Resulting from Conflict Between Ship Navigation and Offshore Structures	250
5. Accidental Deaths on Oil Industry Structures and Vessels	252
F. A Matrix Analysis of Some Possible Adverse Impacts on the Environment and Related Uses	255
1. Purpose	255
2. Significant Resource Factors	255
3. Impact-Producing Factors	256
4. Analytic Procedures	257
G. Recapitulation of Matrices	330
1. Refuges/Management Areas	330
2. Estuary/Marsh/Nursery Areas	330
3. Biota Seaward of Estuary Nursery Areas	330
4. Beaches	331
5. Shipping	331
6. Outdoor Recreation	332
7. Commercial Fishing	332
8. Sport Fishing	333
Bibliography	335

IV. MITIGATING MEASURES INCLUDED IN THE PROPOSED ACTION

A. Oil Spills	343
1. Regulations	346
2. Inspections	349
3. Enforcement	352
4. Contingency Action	357
B. Structures	363
C. Pipelines	368

	Page
D. Other Mitigatory Measures	375
1. Special Stipulations	375
2. Notices to Lessees and Operators	376
3. Departures	377
4. Research on Advanced Technology	377
5. Geophysical Information	378
6. Conservation Practices	380
7. Other Requirements	383
 V. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS	
A. Oil Pollution Effects on Marine Environment	384
B. Pipeline Construction Effects on Marshes and Bottom Resources	388
C. Disposal of Oil-Field Brines	389
D. Structures in Conflict with Commercial Fishing	390
E. Structures in Relation to Shipping	391
F. Oil Pollution Effects on Recreational and Cultural Resources	392
G. Debris Resulting from OCS Operations	393
 VI. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE AND MAINTEN- ANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY	394
 VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES	
A. Mineral Resources	398
B. Land	398
C. Fish and Wildlife Resources	398
 VIII. ALTERNATIVES TO THE PROPOSED ACTION	

A. Hold the Sale in Modified Form	400
B. Withdraw the Sale.	402
1. Increased Imports.	407
2. Increase Onshore Oil and Gas Production. . .	432
3. Increased Nuclear Power.	451
4. Increased Use of Coal.	464
5. Increase Hydroelectric Power	495
6. Modification of FPC Natural Gas Pricing. . .	499
7. Oil Shale Production	505
8. Wellbore Stimulation for Recovery from Known Deposits.	528
9. Increase LNG Imports	538
10. Synthetic Natural Gas and Oil.	548
11. Energy Conservation.	560
12. Combination of Alternatives.	576
C. Delay Sale Until New Technology is Available to Provide Increased Environmental Protection. . .	582

IX. CONSULTATION AND COORDINATION WITH OTHERS

A. Federal.	584
B. State.	584
C. Public	584

X. ATTACHMENTS

1. Attachment A - Tentative OCS Leasing Schedule
2. Attachment B - Description of Blocks by Water Depth,
Distance from Shore, Acreage, and Estimated Production
3. Attachment C - Geologic Time Chart
4. Attachment D - Summary of Recreation and Fish and
Wildlife Areas Along the Gulf of Mexico Coast--
Louisiana and Texas
5. Attachment E - Equipment Available for Emergency Oil
Spill Control and Cleanup
6. Plat - Depiction of Blocks Proposed for Leasing

Note:

This draft environmental statement has been prepared pursuant to section 102(2)(C) of the National Environmental Policy Act of 1969.

The regulations to which reference is made throughout this environmental statement are 30 CFR Part 250 and 43 CFR 3300, and Geological Survey OCS Orders Nos. 1 through 12 - Gulf of Mexico. Although too bulky to append here, these may be obtained from the United States Department of the Interior.

I. DESCRIPTION OF THE PROPOSAL

A. Background of Proposal

"For most of our history, a plentiful supply of energy is something the American people have taken very much for granted. In the last twenty years alone, we have been able to double our consumption of energy without exhausting the supply. But the assumption that sufficient energy will always be readily available has been brought sharply into question within the last year. The brownouts that have affected some areas of our country, the possible shortages of fuel that were threatened last fall, the sharp increases in certain fuel prices and our growing awareness of the environmental consequences of energy production have all demonstrated that we cannot take our energy supply for granted any longer.

A sufficient supply of clean energy is essential if we are to sustain healthy economic growth and improve the quality of our national life. I am therefore announcing today a broad range of actions to assure an adequate supply of clean energy for years ahead . . .1/"

President's Clean Energy Message
June 4, 1971

1/ U.S., President, "The President's Message to the Congress, June 4, 1971," Weekly Compilation of Presidential Documents, Vol. 7, No. 23, June 7, 1971, pp. 855-866.

The U.S. is the single largest energy-consuming nation in the world, accounting for one-third of the world's total consumption. The growth in domestic demand for electric power and industrial demand for energy has caused a sustained high level of energy demand; from 1960 to 1970 demand increased at an average rate of 4.3 percent per year.

Overall Energy Requirements for the 15 Year Period 1970 to 1985 1/

	Quantity	1970 Percent of energy supply	Quantity	1985 Percent of energy supply
Coal (1,000 short tons)	526,650	20.1	850,000	18.4
Crude petroleum (million bbls)	5,367	43.0	8,600	43.5
Natural gas (billion cu. ft.)	21,847	32.8	38,200	24.3
Hydropower (billion kil. hr)	246	3.8	363	3.7
Nuclear power (billion kil. hr)	19	<u>0.3</u> 100.0	1,982	<u>19.1</u> 100.0

1/ Dupree, W.G. and J.A. West. 1972. United States energy through the year 2000. U. S. Department of the Interior, Washington, D.C. (Dec., 1972).

The President's Clean Energy Message alerted the nation to the possibility of insufficient supplies of clean energy unless prompt action were taken. He proposed measures designed to alleviate the projected short-fall in supply. One of these measures was the development of energy resources on Federal lands and specifically the oil and gas resources of the Outer Continental Shelf. The Department was directed to accelerate OCS offerings of oil and gas leases and to prepare a tentative five-year schedule of lease offerings. On June 15, 1971, the Department complied and made available to the public such a schedule. (Attachment A). This proposed lease sale is the fourth sale identified in this release.

B. Tentative Five-Year Schedule

The tentative schedule is currently being updated and revised within the Department. Improved resource information has been acquired and the overall supporting analysis is being refined in line with the current energy situation. In the development of the first schedule, the Department considered its three leasing objectives; orderly resource development, protection of the environment and receipt of fair market value. These objectives constitute overall policy parameters for the OCS program and consideration accorded to each may vary from one component to another. An analysis was made in broad terms of when,

where, and how much oil and gas acreage to offer for lease. This was done through a review of the national energy situation and the identification of future supply-demand imbalances. Deficits were identified by matching projections of future non-OCS supplies of oil and gas and future OCS production from existing leases with future projected demand. Demand forecasts were made on a regional basis, using the regions of the Future Requirements Committee for gas and the Petroleum for Administration of Defense districts for oil. New OCS sales were proposed in line with helping to meet the deficits. Different alternative schedules were tested with respect to their impact on demand.

These different options were also reviewed from the perspective of receipt of fair market value. The size and frequency of sales can induce or inhibit a competitive market which in turn affects the Government's receipt of fair market value. Currently, in order to promote competition and sufficient capital for bonus payments and development of leases, two general sales of 300,000-600,000 acres each are scheduled per year.

The policy decision under which the current tentative lease sale schedule was determined that lease sales would generally be within 300-600 thousand acres in size was based upon analyses that the range is large enough to generate sufficient interest in a sale and not too large to reduce competitive levels unreasonably. The

matter of the appropriate size of sales is the subject of continued study within the Department's management objectives of orderly resource development, protection of the environment, and receipt of fair market value.

Under the tentative five-year schedule, an environmental impact statement based upon detailed analysis of all appropriate data will be prepared for each proposed OCS oil and gas lease sale included in the five-year schedule. Detailed studies designed to analyze environmental impacts of proposed OCS lease sales have been initiated for the Mississippi-Alabama-Florida area of the Gulf of Mexico. In addition, an environmental analysis of the cumulative impact of OCS oil and gas operations is being initiated.

Prior to any decision to lease OCS lands in the Gulf of Alaska and Mid-Atlantic areas, broad planning studies of the environmental, natural resources, mineral, economic and other regional factors must be made available and carefully analyzed. An in-house data reconnaissance study on the Mid-Atlantic area 1/ has been completed and one on the Gulf of Alaska is in progress. These studies will only serve as the first step in our data gathering efforts. Until the results of these studies, and others that may be necessary, are fully evaluated, no decision to initiate leasing

1/ Library Research Project Mid-Atlantic Outer Continental Shelf (Reconnaissance), Dept. of Interior, Bureau of Land Management, December, 1972.

programs in these areas can be made. In addition, the question of respective Federal and State OCS jurisdiction in these offshore areas is currently in litigation. Resolution of this issue is necessary before a decision on leasing actions can be made.

C. Activity, Environment, and Impact from the Five-Year Schedule in the Gulf of Mexico

1. Proposed Sales

Sales tentatively included in the five-year schedule (excluding possible Gulf of Alaska and Atlantic areas) are:

1. Gulf of Mexico Drainage (held November 1971)
2. E. Louisiana General and Gulf of Mexico Drainage (held September 1972)
3. Louisiana General and Gulf of Mexico Drainage (held December 1972)
4. East Texas General and Gulf of Mexico Drainage (this proposed action)
5. Alabama, Mississippi and Florida General and Gulf of Mexico Drainage
6. Louisiana and East Texas General and Gulf of Mexico Drainage
7. Gulf of Mexico Drainage
8. Louisiana and Texas General and Gulf of Mexico Drainage
9. Gulf of Mexico Drainage
10. Gulf of Mexico General and Drainage

2. Development

The following table indicates the intensity of activity that will be required in order to develop the hydrocarbon reserves believed to underlie areas included in the five-year schedule in the Gulf of Mexico.

	<u>Current Status</u>	<u>Increment: 1/ 5-yr. Schedule</u>	<u>1976 Status</u>
a. Acres under lease (millions)	4.0	2.6 - 3.6	5-6 <u>2/</u>
b. Reserves to be developed:			
- oil (bil. bbl)	3.2	2.5 - 5.0	
- gas (tcf)	24.0	20 - 40	
c. Remaining reserves:			
- oil (bil. bbl)			2.75 - 4.0
- gas (tcf)			35 - 45
d. Holes	10,544	3,500 - 4,500	13,500-15,500
e. Platforms	1,935	800 - 1,400	2,600- 2,900
f. Miles of Pipeline	6,019 <u>3/</u>	1,020 - 3,000	7,000- 9,000
g. Terminals	74	14 - 28	90 - 100
h. Storage Facilities	82	16 - 32	100 - 120

1/ All figures are for development over the life of the leases issued during the five-year period.

2/ This assumes that some leases will have expired or will have been relinquished.

3/ Includes approximately 3,100 miles of common carrier pipeline.

3. Environment

The coastal zone of the Gulf of Mexico is richly endowed with estuaries and coastal marshes. Over 200 estuarine systems extend from Florida Bay and the famous Ten Thousand Islands of the Everglades to the hypersaline Laguna Madre of the Southwest Texas coast. It is estimated that there are about 12.7 million acres of estuary and coastal marsh habitat in the five states bordering the Gulf of Mexico. This is about 45 percent of the total estuary and coastal marsh area in the contiguous 48 states, about two-thirds of the coastal marshes and one-third of the estuarine water area. It is this area of shallow estuaries and marshes that makes the Gulf of Mexico so productive of fish and wildlife resources. 1/

From the shoreline of the barrier islands of the Gulf, waters deepen gradually at a rate of about six feet per mile out to depths of about 300 feet, where the gradient increases more rapidly out to the shelf break or continental slope. In some areas the shelf is more than 100 miles wide. The Gulf Coast area lies, generally, in a zone of transition between tropical and temperate weather patterns. The climate is mild (mean temperature 69^o F.) and the area receives

1/ U.S. Congress, Senate, Report of the Secretary of the Interior to the U.S. Congress, the National Estuarine Pollution Study, 91st Congress, Second session, March 1970.

considerable precipitation (55 inches annually). Wind flows are complicated, particularly in the cold months, when the normal track of disturbance traveling west to east lies near the coast.

The Gulf of Mexico is defined ecologically as a high energy system in which the naturally generated energy supply is sufficient to maintain a large and diverse population of plant and animal life. The extensive shallow water area of the Continental Shelf provides a broad expanse of nutrient laden substrate that tends to concentrate commercial species of fish where they can be caught readily.

a. Wildlife

The coastal area in and adjacent to the Gulf of Mexico offers wintering and nesting areas for a large proportion of the waterfowl population of the United States. It is the southern terminal for much of the Central Flyway and both the Mississippi and Atlantic Flyways. Twenty-five National Wildlife Refuges, including 486,780 acres are located in the area. These are distributed as follows:

	National Wildlife <u>Refuges</u>	<u>Acres</u>
Texas	5	131,333
Louisiana	5	232,476
Florida	15	122,971

In addition, 66,250 acres of wildlife habitat adjacent to the refuges have been closed to hunting by Presidential Proclamation.

Each State, including Louisiana, Alabama and Mississippi, Florida, and Texas, also operates several wildlife refuges or management areas adjacent to the Gulf of Mexico.

b. Fishery Resources

The rich, nutrient laden estuaries of the Gulf of Mexico produce an abundance of sport and commercial fish. Major species by type of estuarine dependence are: 1/

Sport Fish

Residents While Juveniles
and Adults

Crabs, Spotted Sea Trout,
Oysters, Snook

Residents While Larvae
and Juveniles

Croaker, Tarpon, Black
and Red Drums, Spot,
Mullet, Sand Sea Trout,
Whiting, Shrimp, Flounder,
Salt Water Sheepshead,
Salt Water Catfish, Blue-
fish, Ladyfish

Commercial Fish

Oysters, Blue Crabs,
Spotted Seatrout,
Stone Crab

Same as above plus
Menhaden but not Tarpon

1/ The National Estuarine Pollution Study, op. cit., p. 116.

c. Recreation

The Gulf of Mexico offers a wide variety of outdoor recreation opportunities. The recreational resources of the areas are summarized as follows: 1/

Florida

Florida's total recreation shoreline on the Gulf of Mexico is 1,755 miles including 111 miles of public recreation areas and 771 miles of beach. Approximately half of the entire shoreline (840 miles) consists of mangrove swamps or marsh. All water oriented recreation activities are feasible in the area, but swimming and fishing are the most popular.

Alabama

Total recreation shoreline in Alabama is 204 miles including 115 miles of beach and 89 miles of marsh shore and only 3 miles of public recreation areas. Swimming, fishing, sailing and boating are suited to the area and are the most popular recreation activities.

Mississippi

Mississippi's total recreation shoreline is 203 miles including 69 miles of marsh shore and 134 miles of beach. The Mississippi mainland shoreline lies some miles behind a widely broken chain of

1/ All statistics pertaining to outdoor recreation were taken from, Shoreline Recreation Resources of the United States, Outdoor Recreation Resources Review Commission, Report No. 4, 1962.

offshore islands (Petit Bois, Horn, Ship and Cat Islands), which protect the shore from the open Gulf. The area is best suited for such recreation activities as swimming, fishing, sailing and boating.

Louisiana

Louisiana's total recreation shoreline (including Lake Pontchartrain) is 1,076 miles including 819 miles of marsh shore and 257 miles of beach. Fishing, hunting, wildlife study, boating, and related activities are best suited to the area. Swimming is feasible but the nature of most beaches and offshore bottom make them less than attractive. 1/

Texas

Area available for recreation in the Texas coastal zone is 23.3 square miles, or 0.2% of the total land area in the coastal zone. 2/ This recreation area includes 343 linear miles of beach and 359 miles of marsh shore. The shorelines are probably as little developed as any beach areas in the United States. All water oriented types of recreation activity are feasible on the Texas shore.

1/ See also section I. E. "Recreation Resources".

2/ Flawn, P. T. and B. Fisher, 1970. Land-use Pattern in the Texas Coastal Zone. in The coastal resources management programs of Texas, appendices. ed. by J. T. Goodwin and J. C. Mosely, Coastal Resources Management Program, Office of the Governor, Austin.

National Park Service Units 1/

National Park Service units in the Gulf of Mexico area are:

Padre Island National Seashore
Gulf Islands National Seashore
DeSoto National Monument
Everglades National Park
Fort Jefferson National Monument

Potential new areas are:

Suwanee Wild and Scenic River
Jean Lafitte National Cultural Park
Wakulla River National Monument or Wild
and Scenic River

In addition to Federal areas, the following National Landmarks are located in the Gulf of Mexico area:

Fort Morgan National Historic Landmark
Fort San Marcos De Apalche National Historic Landmark
Safety Harbor Site National Historic Landmark
Lignumvitae Key Natural Landmark

4. Resource Use and Commercial Activity Related to the OCS in the Gulf of Mexico

The following major activities and resource uses occur on the OCS or are related to the OCS of the Gulf of Mexico.

a. Mineral Industry

The petroleum refining industry and the related extraction industries of Louisiana and Texas have a growth rate several times greater than the national rate for industries of

1/ Current data, National Park Service.

this type. In 1971, Gulf of Mexico OCS operations produced more than 387 million barrels of oil and condensate valued at \$1.38 billion, and about 2.8 trillion cubic feet of gas and over 1.5 billion gallons of gas liquids valued at over \$625 million. Total sulphur production on the outer continental shelf was 1,178,400 tons valued at \$23,718,311. In addition, 370,406 tons of salt were produced in 1971 with a value of \$66,673.

b. Commercial Fishing

The Gulf of Mexico is one of the most productive fishing areas in the United States. In 1971, the commercial fishing catch was 2.097 billion pounds valued at \$199.8 million (paid to fishermen). This catch was 42.2 percent of the volume and 31.0 percent of the value of the total United States commercial fisheries catch in 1971.

c. Sport Fishing

In 1970, an estimated 2.4 million fishermen, 12 years and older, spent 25.7 million man-days of fishing in the Gulf of Mexico. Approximately 53 percent of this sport fishing was in the ocean or from beaches and 47 percent was in estuaries. 1/ No projections are available for 1976, but the 1970 level is expected to increase.

1/ Projected from 1965 National Survey of Fishing and Hunting and 1965 Salt Water Angling Survey; U.S. Fish and Wildlife Service, and preliminary 1970 Salt Water Angling Survey, National Marine Fisheries Service.

d. Recreation

In 1970, recreationists participated in 215 million recreation activity occasions 1/ in the Gulf of Mexico area; by 1975 it is expected that recreationists will participate in approximately 250 million recreation activity occasions in this area. 2/ Recreation activities in the Gulf area are, of course, largely water-oriented. Water-oriented recreation is the most popular form of outdoor recreation in the United States. The warm climate of the Gulf of Mexico makes this area very attractive to recreationists both in, and beyond, the region.

Last year's and estimated future visits to National Park Service Units in the Gulf of Mexico are as follows:

	<u>Visits in 1971</u>	<u>Estimated Visits 1976</u>
Padre Island	904,400	1,165,900
Gulf Islands	0	2,052,600
De Soto N. Mon.	135,500	161,600
Everglades	1,293,500	1,428,200
Ft. Jefferson	10,500	20,900

1/ A recreation activity occasion is the participation in a single activity by a single individual.

2/ The above estimates for recreation use are based on data and procedures contained in A New Perspective on Recreational Use of the Ocean, National Planning Association, Winslaw and Bigler. The above estimates are included for the purpose of presenting order of magnitude data and could be subject to considerable adjustment.

e. Shipping

The Gulf of Mexico is subject to heavy shipping traffic. The following is an analysis of shipping traffic (daily distribution in the Gulf of Mexico) 1/.

<u>All Vessels Over 100 GRT*</u>			
<u>Location</u>	<u>1969</u>	<u>1972</u>	<u>1980</u>
Straits of Florida	19	27	21
Eastern Gulf of Mexico	17	19	17
Western Gulf of Mexico	9	6	10
Mobile Area	62	77	73
Ent. to Miss. R.	18	16	19

*Gross Tons

f. Military Use

Some areas of the Gulf of Mexico are designated by branches of the U.S. Armed Forces to be used exclusively for military purposes, such as practice gunnery, bombing, and rocket-firing ranges. Other areas are designated as dumping grounds for both military and civilian use. A possible restraint on the extent of future offshore oil and gas leasing involves conflicts in some areas between mineral development and high priority uses of the Department of Defense. Some adjustments in Defense "Warning Areas"

1/ A Study of Maritime Mobile Satellites, Vol. I, - Merchant Vessel Population/Distributors Present and Forecast, Automated Marine International, Newport Beach California.

(these are principally testing and training areas) on the OCS and/or development of adequate special oil and gas lease stipulations, where appropriate, will need to be made before mineral leasing in such areas can proceed.

g. Research and Education

Besides applied research in petroleum geology, ocean engineering, commercial fishing, fish farming, and other fields, a number of Gulf States colleges and universities are involved in basic research in the marine sciences. The shoreline and open waters of the Gulf of Mexico serve as an important outdoor laboratory. The following table lists colleges and universities, and degrees offered, that carry out part or all of their field education and research in the Gulf.

An example of this emphasis on field research in the Gulf involves the plans of Texas A & M University to establish Flower Garden Ocean Research Center 1/. If the University's plans are implemented 2/, the

1/ Marine Biomedical Institute, Texas A & M University, 1971. The Texas Tektite Project: Flower Garden Ocean Research Center, Gulf of Mexico. Misc. brochure, Texas A & M University, Galveston. 21 pp.

2/ Texas A & M has filed an application with the Department of Interior for withdrawal of certain OCS lands for this specific purpose. The application is under review.

COLLEGES, UNIVERSITIES AND RESEARCH INSTITUTES
UTILIZING THE GULF OF MEXICO FOR RESEARCH AND EDUCATION

Institution	Location	Degree Offered/Research Activity
Univ. of Alabama	Bayou La Batre	Undergrad courses; research
Fla. Institute of Technology Fla. State University	Melbourne Tallahassee	B.S., M.S. in Oceanography M.S., Ph.D. in Marine Biology, Oceanography Ph.D. in Geophysical Fluid Dynamics
Univ. of Florida	Gainesville	M.A., M.S., Ph.D. in main departments with emphasis in Marine Science
Rosenstiel School of Marine and Atmospheric Science-- Univ. of Florida	Miami	M.S., Ph.D. in Marine Biology Science, Marine Geology and Geophysics, Physical Oceanography, Chemical Oceanography, and Atmospheric Sciences
Nova University Oceanographic Laboratory	Fort Lauderdale	Ph.D. in Physical, Chemical Oceanography, Marine Biology, Physics (marine emphasis)
Univ. of South Florida Marine Science Institute Univ. of West Florida	St. Petersburg Pensacola	M.S. in Marine Science M.S. Biology--Estuarine, Marine Studies
Louisiana State University	Baton Rouge	M.S., Ph.D. in Marine Sciences
Gulf Coast Research Laboratory	Ocean Springs, Miss.	Affiliated with 29 Gulf States Colleges and Universities; M.S., Ph.D. in Biological Sciences (marine emphasis)
Institute of Engineering Tech. Miss. State University University of Southern Miss.	State College Hattiesburg	Bach. of Engineering Tech. (marine emphasis) M.A., M.S. in Biology, Geology
Gulf Univ. Research Corp.	College Station, Tex.	Consortium of 21 universities and research institutes of Gulf States; basic and applied research in all areas of marine science.
Univ. of Houston	Houston, Tex.	M.S. in Biology, Geology, Ph.D. in Biology (marine emphasis) J.D. with emphasis in marine law
Lamar State College of Tech. Marine Biomedical Institute	Beaumont Galveston	B.S. in Oceanographic Technology Doctoral and Postdoctoral training in marine biomedical sciences
Rice University	Houston	M.A., Ph.D. in Geology, Geophysics, Geochemistry
Texas A & M University	College Station	M.S., Ph.D. in Oceanography, Zoology, Botany, Microbiology, Biology (marine emphasis) M.S. in Marine Resource Management
Texas Christian Univ.	Fort Worth	M.S. in Biology, Environmental Science, Geology (marine emphasis)
Texas Maritime Academy-- Texas A & M University	Galveston	B.S. in Marine Engineering, Marine Transportation
Univ. of Texas at Arlington	Arlington	M.A. in Biology, Chemistry, Physics, M.S. in Geology (all with marine emphasis)
Univ. of Texas	Austin	M.A., Ph.D. in Botany, Chemistry, Geology, Microbiology, Physics, Zoology, Engineering, (marine emphasis)
University of Puerto Rico	Mayaguez	M.S. in Marine Science

facility would be located in 80 feet of water about 120 nautical miles SSE of Galveston, Texas. Facilities proposed by the University consist of an offshore platform with laboratory modules, living quarters, power generators, and support facilities. On the coral reef below, there would be placed a Tektite-type undersea habitat.

h. Land and Water Conservation Fund

The Land and Water Conservation Fund was formed to develop and preserve outdoor recreational resources for the benefit and enjoyment of all American people of present and future generations.

Oil and Gas, sulphur, and salt royalties credited to the U.S. Treasury from Outer Continental Shelf operations together with lease rentals and bonuses from OCS lease sales are in turn credited to the Land and Water Conservation Fund in amounts necessary to bring that fund to \$200 million for fiscal years 1969 and 1970, and \$300 million for 1971 and 1972, as follows:

<u>Fiscal Year</u>	<u>Fund Requirement</u>	<u>Funds From OCS</u>	<u>Per Cent From OCS</u>
1969	\$200 Million	\$126.9 Million	63
1970	\$200 Million	\$107.9 Million	54
1971	\$300 Million	\$210.1 Million	70
1972	\$300 Million	\$223.7 Million	75

Revenue funding also comes from entrance and user fees charged at designated Federal recreation areas, motorboat fuel taxes, and the sale of surplus Federal real estate.

The Contingency Reserve portion of the Land and Water Conservation Fund is a small percentage of the State's share of annual appropriations, set aside to assist the States in financing half the cost of special situations where a unique and valuable area is endangered by helping State and local governments acquire lands which may otherwise be lost to recreation and conservation purposes.

Grants-in-aid under the Fund program can be made only to the States, their cities and counties, and legal political subdivisions. The Federal money pays half the cost of statewide planning projects, land acquisition and development of facilities for public outdoor recreation. Appropriations to the

Fund also pay land acquisition costs for authorized areas being added to the national system of parks, forests, wildlife refuges, wild and scenic rivers, and scenic and recreation trails.

5. Possible Environmental Impacts from OCS Oil and Gas Development Resulting from Implementation of the Five-Year Lease Schedule

The environmental impact which would result from implementation of the five-year lease schedule can be estimated with fair accuracy only after specific factors related to each sale are known. For example, at least the following information is needed but is not immediately available for sales beyond the offshore Texas area: (a) location of tracts in relation to resources, shipping lanes, recreation areas, refuges, etc., (b) type of expected production, e.g., oil or gas, (c) geologic formations, (d) water depths, (e) expected terminal points for pipelines, and (f) expected size and location of required new storage facilities.

In general, it can be assumed that future impacts of OCS oil and gas lease sales, both favorable and unfavorable, will be greater on the environment, on other industries, and on communities in areas where no previous OCS oil and gas leasing has been undertaken. This is so because new pipelines and

storage facilities must be built, relationships must be developed between existing industries, (e.g., fishing and the oil and gas industry), and new labor forces and new payrolls will be introduced to the areas. In short, incremental impacts, both positive and negative, will be greater than for similar lease sales offshore Louisiana and Texas where offshore and nearby onshore production has been in existence for many years.

The general impacts expected to result from the implementation of the five-year schedule are expected to be similar to those described in this statement for the proposed East Texas OCS lease sale. The following table summarizes possible positive and negative impacts that could occur as a result of implementing the five-year lease schedule. More specific relationships cannot be identified until detailed analysis has been completed for each of the proposed sale areas.

General Summary of Environmental Impacts Which
Might Result From OCS Oil and Gas Operations 1/

Impact Sustaining Factors	Impact Producing Factors							
	Debris	Plat- form	Oil Spill	Pipel Const	Storage Facil.	Support Serv.	Labor Force	Prod.
1. Refuges	(-)		(-)	<u>4/</u>	<u>4/</u>			
2. Estuaries	(-)		(-)	(-)				
3. Marshland	(-)		(-)	(-)	(-)	(-)		
4. Beaches	(-)	<u>2/</u>	(-)	<u>4/</u>	<u>4/</u>			
5. National Park Units	(-)	<u>2/</u>	(-)	<u>4/</u>	<u>4/</u>			
6. Com. Fish.	(-)	(-)	<u>3/</u>	<u>5/</u>				
7. Sport Fish.	(+)	(+)	<u>3/</u>	<u>5/</u>				
8. Recreation	(-)	<u>2/</u>	(-)					
9. Shipping		(-)						
10. Regional Economy		(+)		(+)	(+)	(+)	(+)	(+)

- 1/ The principal type of relationship between impact producing and sustaining factors is indicated by (+) positive impact or (-) negative impact. In some relationships, both positive and negative relationships are possible, in these areas, the type of relationship considered dominant is shown.
- 2/ Impact will be negative only if platforms are visible, i.e., impact will be on aesthetic values.
- 3/ Impact of oil pollution on nearshore and estuarine shellfish is negative; impact on open-water finfish and shellfish is not well understood, but oil spills adversely affect sport and commercial fishing activity.
- 4/ Impacts would be excluded by administrative action, e.g., pipelines or storage facilities would not be permitted in refuges, National Park Units, or on those recreation beaches subject to official regulation.
- 5/ Impacts would occur during construction stage only.

D. Location and Reserves

The sale area under consideration includes 129 tracts 1/ offshore Texas and Louisiana (from the Galveston Areas east through the East Cameron, South Addition Area). These tracts, if leased, would add 672,643 acres, an increase of about 172% to the current total of 405,134 (as of June, 1972) acres presently under Federal lease offshore Texas. It would also add 25,000 acres, an increase of 0.68% to the total of 3,658,955 (as of June, 1972) acres presently under Federal lease offshore Louisiana. The area is approximately 170 miles long with tracts ranging to 120 miles from shore. Five of the tracts are subject to drainage 2/: and 124 tracts are wildcat, some of which are located in previously developed areas. 3/ The proposed lease sale would be made under Section 8 of the Outer Continental Shelf Lands Act (76 Stat. 462; 43 U.S.C. Sec. 1337.) and regulations issued under that statute.

-
- 1/ The tracts are summarized by water depth, distance from shore, and expected type of production in Attachment B. Also see attached map.
- 2/ Tracts subject to depletion of their oil and gas deposits from wells on adjacent tracts. These tracts are: East Cameron, South Addition, blocks 269 and 335; West Cameron South Addition, blocks 528, 586, and 595.
- 3/ Tracts that are generally located five or more miles from tracts with established production.

Estimated Recoverable Reserves:

	<u>Estimated Volume 1/</u>	<u>Estimated Market Value 2/</u> (\$million)
Recoverable Oil Reserves	30-60 million bbls.	110-220
Recoverable Gas Reserves	5.4-7.6 trillion cu. ft.	1900-2660

It is estimated that the proposed leases may produce 5,000-11,000 bbls. of oil per day and .75-1.05 billion cu. ft. of gas per day by the sixth year after leasing.

Production from OCS leases in the Gulf of Mexico area during 1971 amounted to approximately 387 million barrels of oil and 2,761 billion cubic feet of gas. This production represented approximately 92 percent and 99 percent, respectively, of all oil and gas produced during the year from OCS lands in the United States.

Production from OCS leases offshore Texas during 1971 amounted to approximately 1.7 million barrels of oil and condensate and 127 billion cu. ft. of gas. This operation represented approximately 0.5 percent and 5 percent, respectively, of all oil and gas produced during the year from OCS lands in the Gulf of Mexico. In 1971, 12.03 percent of domestic U.S. oil production and 12.18 percent of domestic gas production came from the Outer Continental Shelf. 3/

1/ U.S. Geological Survey, Informal Preliminary Staff Estimated, Undated, Unpublished.

2/ Ibid.

3/ See also section VIII.B.2., "Onshore Oil and Gas Production," of this statement.

E. Tract Selection

Having determined through development of the tentative five-year schedule, the timing, size, and location of a specific sale, it must be determined which tracts should be offered in the sale. A call for nominations of tracts is issued by the Department. Industry responds by nominating tracts in which they are interested. With improved seismic, geologic and economic data on the specific sale under consideration, the Department analyzes the past leasing history of tracts under consideration and the nominations themselves and makes an initial identification of tracts to be included in the sale.

1. Responsibilities and Procedures

Responsibility for the initial selection of tracts lies with the field offices of the Bureau of Land Management (BLM) and the U.S. Geological Survey (GS) under guidance as to Departmental objectives furnished by the respective Washington offices.

a. BLM-New Orleans Office (NO) is responsible for furnishing the historical and current leasing status of all tracts nominated and their locations with respect to fairways, anchorage and warning areas, and pipelines. BLM-NO makes preliminary identification of tracts based on the following criteria: number

of weighted and unweighted nominations 1/; need to initiate leasing in rank wildcat areas from an economic standpoint; tract history; nomination patterns; mix of tracts by water depths, distance from shore, and nominators, and through analysis of past environmental statements, those types of tracts that have been deleted from past sales or from which special environmental stipulations were developed.

b. GS-NO is responsible for furnishing technical information including geological, geophysical, engineering, and paleontological information in determination of tracts to be recommended for selection. GS-NO identifies tracts based on the following criteria: need to initiate leasing in rank wildcat areas from a geologic standpoint; drainage tracts or those in imminent danger of drainage; tracts for which companies have presented data for GS inspection and evaluation demonstrating their necessity and desirability for further development; tracts which are most prospective for production; other tracts susceptible to prompt drilling and development.

1/ Unweighted: Nomination of a tract by a single company; counts as one nomination.

Weighted: Nomination of a tract by a group or combine of a number of companies; counts as one nomination.

c. The Washington Office of BLM and GS furnish guidelines which flow from the Departmental objectives: orderly and timely resource development, protection of the marine environment ; and receipt of fair market value for leased marine resources. These guidelines include but are not limited to: recommended size of sale; tracts or areas for special consideration; and information relative to Administrative or Department policy. The Washington Office also reviews the joint recommendation of tracts submitted by the BLM and GS field offices for conformity with these objectives and guidelines.

2. Purpose of the Tract Selection Process

It is intended that by this initial tract selection process, tracts which have the highest geological potential normally will be selected. In response to the Department's call for nominations for the East Texas General Sale, 39 oil companies representing 20 bidding groups nominated approximately 5.2 million acres. From this total, a list of 129 tracts comprising 697,643 acres was selected in accordance with the process described above to be included in the proposed sale.

In order to assess the environmental impact which may occur as a result of leasing these tracts, BLM prepares a draft environ-

mental statement, soliciting a wide spectrum of views from Federal, State, and local agencies, and the public. This environmental statement evaluates the potential effect of the proposed lease sale on all components of the environment of the entire area during exploration, development and operational phases. Pertinent published and unpublished resources reports and evaluations are reviewed and portions are included in this statement. In the case of a general sale a public hearing is held. Through these processes, further modification of the list of tracts may result, or special stipulations may be required for the leasing of certain tracts as well as reflected in the final environmental statement.

II. DESCRIPTION OF THE ENVIRONMENT

A. Geologic Framework: Geologic History and Physiography 1/

1. Origin of the Gulf of Mexico

The origin of the Gulf of Mexico has been proposed to be related to the extensive regional subsidence of more than 10,000 feet during Cretaceous time, and its isolation came about by the continuous contemporaneous carbonate growth of the Florida and Yucatan platforms (Wilhelm and Ewing, 1972). Minimum rates of sediment deposition, compared to the rate of platform growth, led to consistent deepening of the gulf, which, accordingly, must be underlain by a thin Cretaceous section.

The Gulf of Mexico has been reduced to its present size by the invasion from the north and northwest of the huge Cenozoic mass of deposits--referred to as the Gulf Coast geosyncline 2/. However, the latest deposits from the Mississippi and other rivers were laid down on the continental shelves and a minimum of terrigenous material has been reaching the abyssal gulf by bottom flow known as turbidity currents. Wilhelm and Ewing (1972) consider the abyssal gulf to be a hemipelagic abyssal environment because of its proximity to land. They note that cores from its floor consist principally of lutites and calcilutites interbedded by thin layers and streaks

1/ A geologic time chart is affixed to this statement as attachment C.

2/ Geosyncline: A very large, trough like depression in the earth's surface; opposed to geanticline.

of silt and fine sand. The Mississippi River has been the principal source of this turbidite material.

Thus, the modern Gulf of Mexico is a large Mediterranean-type sea which extends approximately 1,000 miles east-west and 800 miles north-south and occupies a sedimentary basin in which there has been deposition of terrigenous clastics 1/, carbonates, and evaporites since early Mesozoic times.

The northwestern Gulf coast is an alluvial or deltaic coast, characterized as being quite distant from the nearest mountains, and with runoff and sediment load from the lands having been large and long continued.

The coast of Louisiana and Texas receives the drainage of some ten major rivers. Three major recent deltas now reach the Gulf: the Mississippi-Red, Brazos-Colorado, and Rio Grande deltas.

Interior plains are succeeded by broad coastal plains and continental shelves (Price, 1954). On such a coast, after sufficiently long still-stand 2/, shelf bottoms are smooth except toward their outer margins: reefs of biological origin are inconspicuous, few

1/ Clastics: Interbedded sand, silt, shale

2/ Still-stand: No change in mean sea level.

or absent, and shorelines are smooth or irregularly deltaic. Sandy sediments extend from the shoreline out to about 30 to 60 feet of water depth, followed by silt or sand and mud, with mud further out to the edge of the continental shelf. Mud or silt may extend from deeper waters to the mouth of a deltaic river that drains a large basin. The chief exceptions to the outward banding or zonation of sediments are coarse sediments of local organic or chemical origin or sediments on mounds overlying intrusive salt domes.

2. The Continental Shelf:

The continental shelf is a gently sloping submarine plain of varying width forming part of the border of the continent out to a water depth of approximately 600 feet, at which point the continental slope begins. The continental slope has a steeper gradient, extending from the continental shelf edge to oceanic depths. The Texas-Louisiana shelf between the Mississippi delta and the Rio Grande delta ranges in width from about 70 miles on the west to 140 miles off the Texas-Louisiana border.

The numerous hills rising above the sea floor near the outer edge of the northwestern Gulf continental shelf materially influence the local sediments (Lynch, 1954). The dominant

sediment on the continental shelf west of the Mississippi Delta is mud and sand. In isolated areas near shore, sand predominates to form a sand beach and shore zone. The common heavy minerals of these sediments are amphiboles, epidote, dolomite, pyroxene, ilmenite, and biotite. Near the outer edge of the shelf and on the continental slope there are many topographic features of considerable relief, most being less than 300 feet above the surrounding sea floor, with a few above 600 feet. Numerous natural oil seeps have also been observed in this approximate area (see figure 1 for oil seeps and major sediment types in the Gulf of Mexico).

Stratigraphic studies show that the major sedimentary units in the northern part of the Gulf of Mexico geosyncline are arranged in belts parallel to the northern shoreline of the Gulf of Mexico. These sedimentary units have the general shape of flattened ellipses, with the thicker part of each sedimentary lens being the locus of deposition (depocenters) for a particular depositional epoch.

The Tertiary sediments of the central and western Gulf Coast are composed almost entirely of terrigenous clastics, and are characterized by intertonguing marine and nonmarine strata. Some

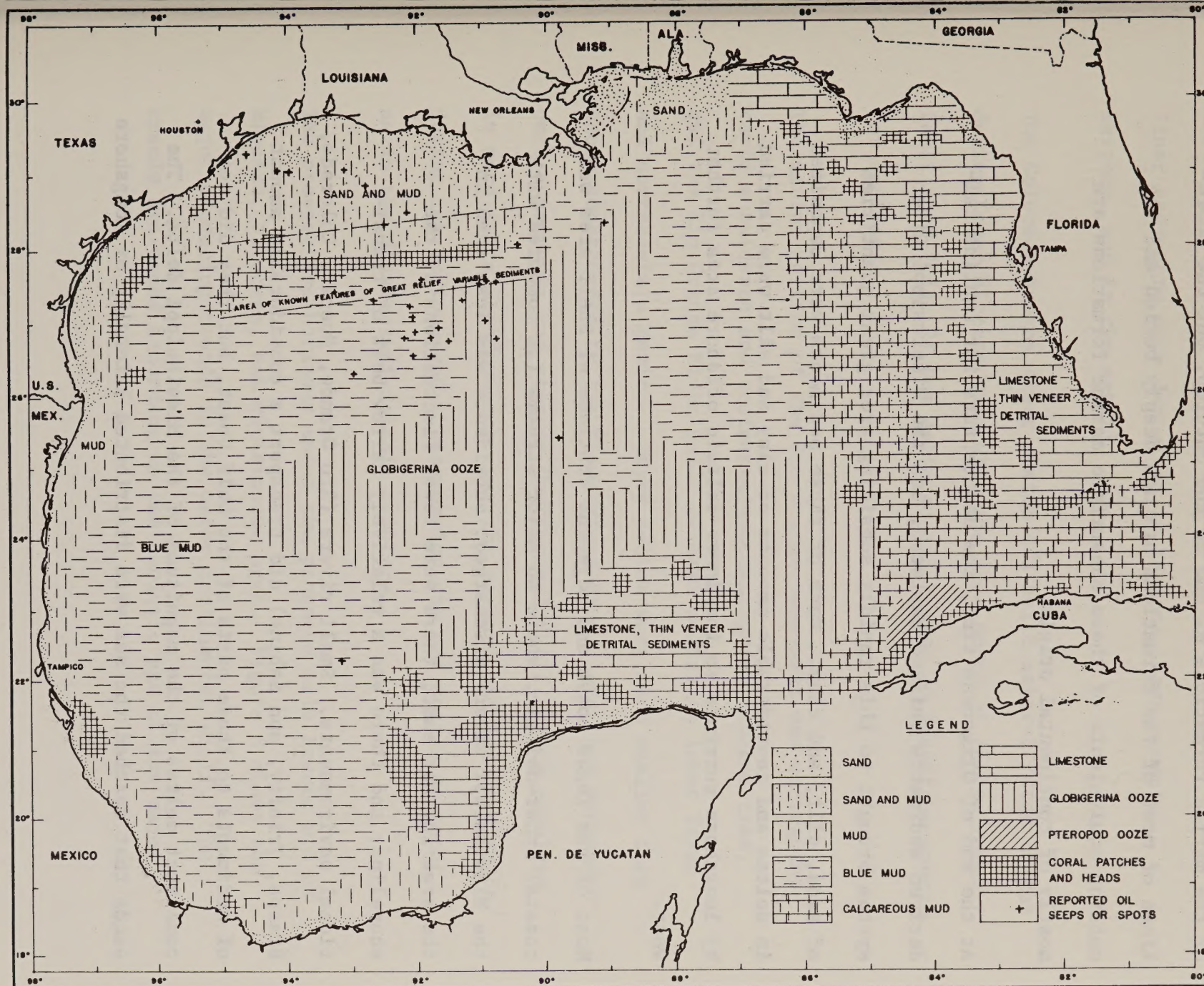


FIGURE 1 —Sedimentary provinces of the Gulf of Mexico. Data compiled from many sources.
(From Lynch, 1954).

of the marine formations extend to the outcrop, but the shorelines of most of the formations are now deeply buried and the outcrop equivalents of these subsurface marine formations are mostly of continental origin.

At the end of Oligocene time, the depocenters for continental-derived sediments shifted eastward, and the Mississippi River system brought to this rapidly subsiding area great quantities of sand, silt, and clay. Much of these sediments were deposited in deltas and considerable amounts of clay and silt were carried by longshore currents to the inner-deltaic offshore area further west.

Most of the Texas coast and adjacent Continental Shelf area was coastal inner-deltaic, where no major streams (as compared with the Mississippi River) discharged; subsidence was less than in the area farther east; there were fewer fluctuations of the shoreline; and there was a relatively narrow belt of transitional environments. Small rivers (Rio Grande, Nueces, Colorado, Brazos, Trinity, and Sabine) did transport a considerable amount of sediments to these parts of the Gulf Coast, but they did not construct deltas of the magnitude of the Mississippi delta. The sands that reached the sea were distributed laterally by longshore

currents and formed various islands by wave actions. The finer sediments were deposited in lagoons, bays, coastal marshes, and in the neritic zone.

The Colorado-Brazos River system did build several large deltas during Lower Miocene time when the area north of the Balcones fault zone (fig. 2) was uplifted and became an important source for sediments.

The marine portion of the Rio Grande Embayment was undergoing rapid subsidence and sedimentation throughout Miocene time, and the Rio Grande River built several deltas in lower Texas and northeastern Mexico. These deltas were much smaller than those constructed by the Mississippi River, and they prograded onto a narrower and steeper Continental Shelf. This resulted in more delta abandonments, but the seaward and landward shift during regressions and transgression was not nearly so great as in the Mississippi deltaic province.

The prospective horizons under the proposed sale tracts are of Miocene, Pliocene, and Pleistocene ages. Figure 3 shows the major producing trends in the outer continental shelf. The trends are named according to the geologic age of the major

hydrocarbon-producing sediments. Figure 4 is a generalized cross section through the sale area. The oldest sediments shown are of Oligocene age and are over 26 million years old. Sedimentation has continued with only minor interruptions to the present time.

Conditions necessary for oil and gas generation and entrapment are reasonably well understood. Generally, sands deposited within and on the fringes of a deltaic environment are favorable, especially the subaqueous portion deposited in ancient, nearshore, shallow marine environments. Very porous thick sands associated with continental environments are generally less favorable. Sands transported by marine shales are also productive in many areas. Local uplifts and faulting serve to localize and concentrate the hydrocarbons into commercial deposits. Pliocene time was a period of uplift and erosion and the sediments that accumulated in the Gulf of Mexico or that were deposited in the coastal environment are, generally, seaward of the present shoreline.

Two distinct provinces are indicated to exist in the Texas Pliocene trend. One province occurs in the Texas offshore area south of the San Marcos Arch and is outside of the sale area. Structurally, the province is characterized by down-

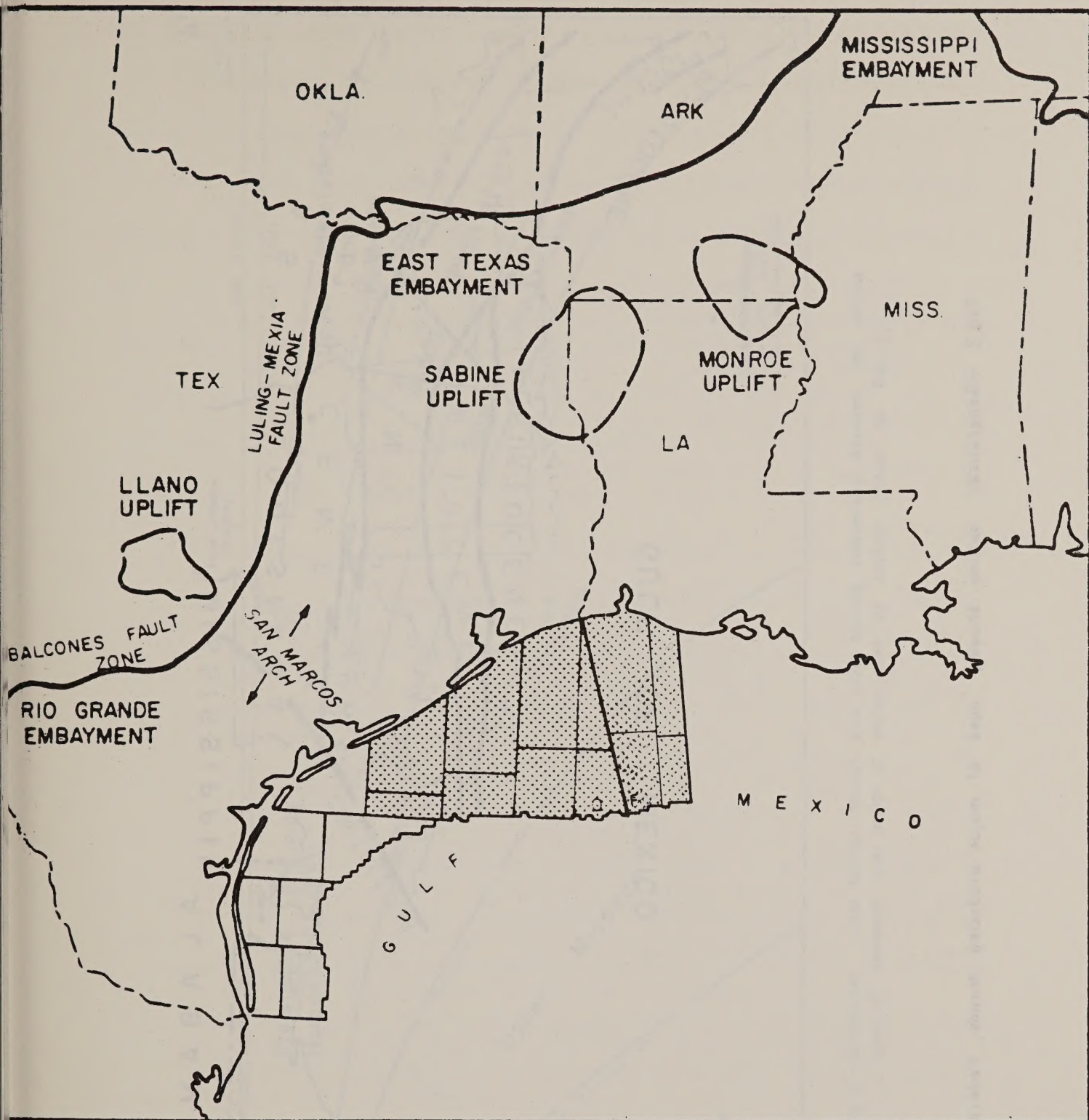


FIG. 2

MAP SHOWING RELATIONSHIP OF SALE
AREA TO MAJOR TECTONIC FEATURES



SALE AREA

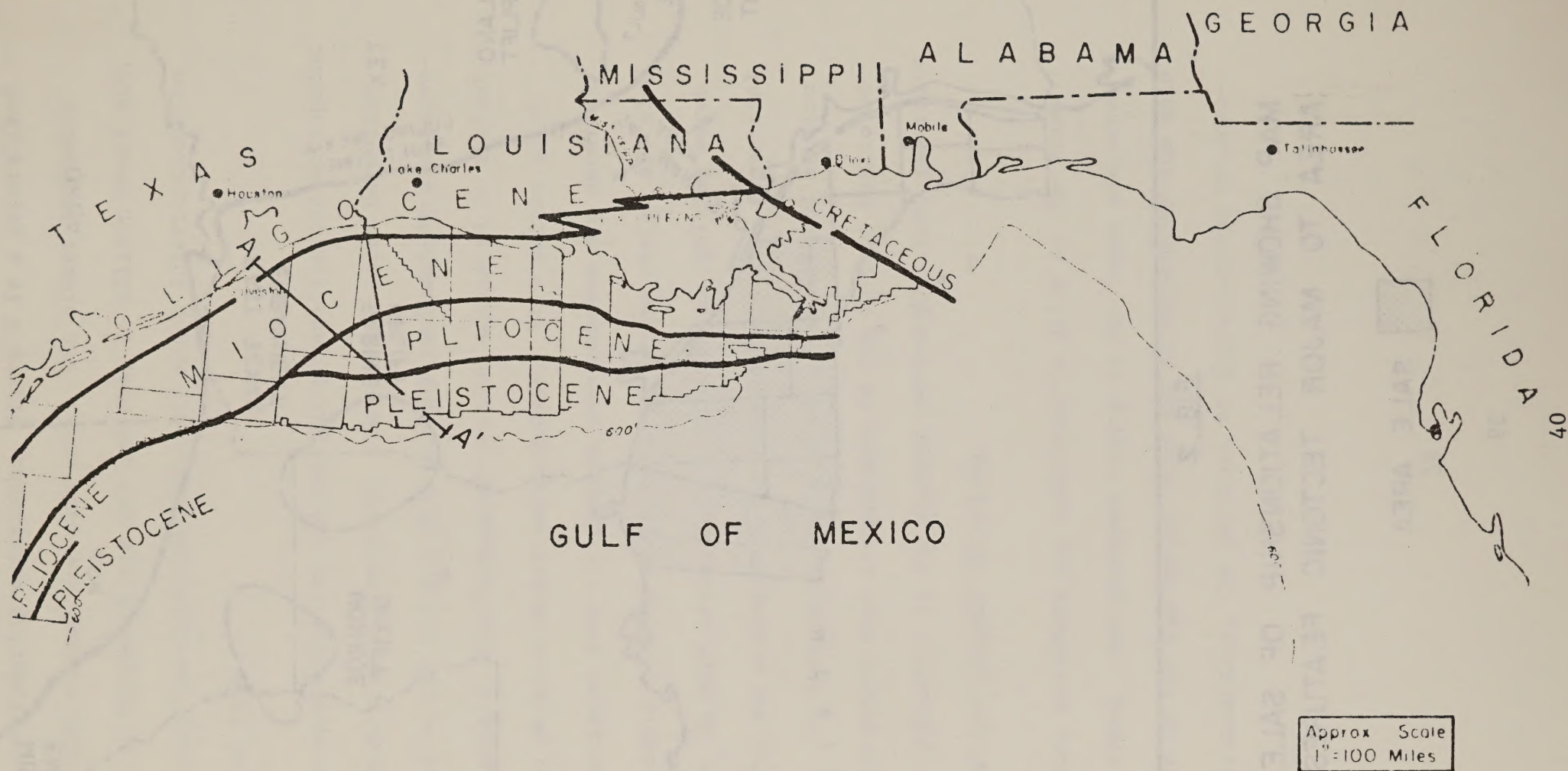


Fig.3 -Generalized outline showing ages of major producing trends, Federal OCS.

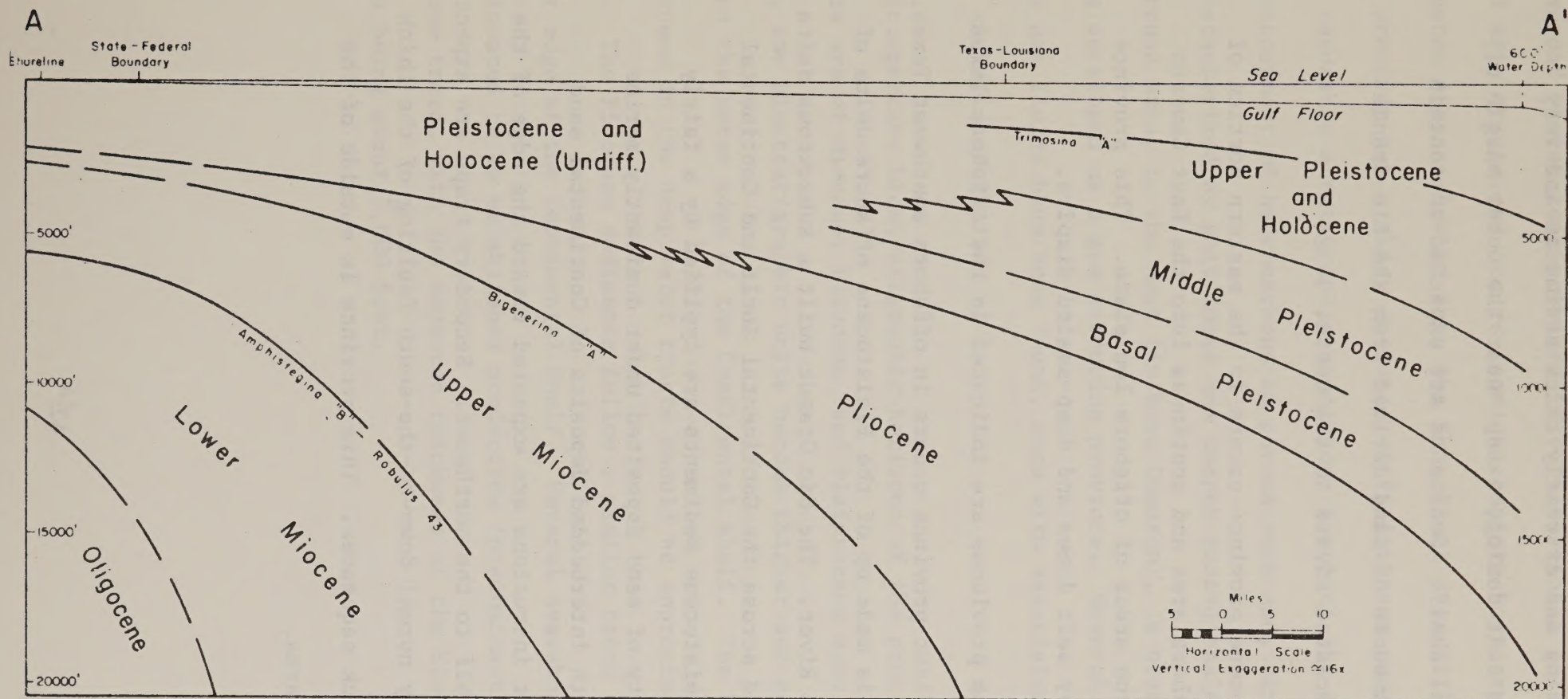


Fig. 4 - Generalized cross section through shelf area, showing relationship between the various ages of sediments and depths of burial. Line of section shown on Fig. 3.

to-south faulting and extremely thick sediments and very little shallow salt doming, except near the outer margin of the Continental Shelf. Sediments are expected to contain considerable amounts of sand derived from the Rio Grande River and associated rivers to the north.

The other Pliocene province occurs in the eastern portion of the Texas offshore area and continues into the East Cameron and West Cameron areas of offshore Louisiana. This province is dominated by salt domes and deep-seated diapirs.

Two Pleistocene provinces are indicated in the offshore Texas region. The first province occurs in offshore southwest Texas, and generally is made up of the Pleistocene offshore delta of the Rio Grande River. The Rio Grande built a subaqueous delta which prograded across the Continental Shelf and Continental Slope. The Pleistocene sediments are typified by a fairly sizable quantity of sand deposited under dominantly marine conditions, with interbedded deposits of Continental sand material. Salt intrusions are expected toward the edge of the Continental Shelf to the northeast. Secondary traps are expected to be formed by normal down-to-the-south faulting of the thick sedimentary rock sequences. This province is outside of the sale proposed area.

The second Pleistocene province is very pertinent to the proposed sale tracts and occurs from the eastern boundary of the Galveston Area eastward into the Ship Shoal area of Louisiana. This province has a thick sequence of Pleistocene sediments with favorable stratigraphic conditions for both the generation and entrapment of hydrocarbons in porous rock and, structurally, is characterized by salt domes and deeper seated shale domes. The trend area, to the east (in West Cameron), is presently being developed as a gas producing province. Several fairly large gas fields have been found, some with associated condensate and oil reservoirs.

The prospective biostratigraphic horizons of the proposed sale tracts are of Miocene, Pliocene, and Pleistocene ages. Regionally, the biostratigraphic units become thicker and get deeper toward the outer edge of the Continental shelf. The Pleistocene thickness in the deep water tracts should be approximately 12,000 feet. The Pliocene sediments follow a similar trend toward the outer edge of the Continental Shelf. Several nearshore tracts are located on an established productive (predominantly gas) Miocene trend, with the expected thickness of the Miocene sediments being about 7,000 feet.

Seismic reconnaissance maps indicate that approximately 77% of the proposed sale tracts are located on salt piercement-type structures, and approximately 21% on deep-seated shale or salt domes. About 2% of the proposed sale tracts are located on features associated with extensive faulting. All of the structural features examined are considered favorable for the migration and entrapment of hydrocarbons.

3. Coastal Louisiana

West of the Mississippi delta regions, coastal Louisiana is predominantly salt marsh. Elevations range from 0 to about 3 ft. above mean sea level. The marshes consist of low tracts of periodically inundated land, supporting grasses, reeds and rushes. The most notable biological feature is the abundant plant life, creating ideal conditions for sediment and organic plant material entrapment.

The Atchafalaya River system is the main distributary of the Mississippi River above Head of Passes, and might have captured the entire Mississippi River discharge earlier in this century had it not been for the construction of controlling dams and levees. By 1950 the Atchafalaya was receiving in excess of 30 percent of the total Mississippi flood waters. Coarser detritus, sands, and silts are carried into Atchafalaya Bay and further westward by longshore

currents. Some of this material forms broad mud flats seaward. Once beyond the bay, fine muds are carried along the coast by westward currents, resulting in cheniers behind a zone of newly developing mud flat marsh. These cheniers, or stranded beach ridges, are a characteristic feature of southwestern Louisiana coastal marshlands. The chenier plain, also referred to as marginal deltaic plain, covers approximately 1,200 square miles and extends westward from Vermillion Bay to Sabine Pass. Another feature of the west central Louisiana coast is the intrusion of masses (domes) of rock salt to within 100 feet of the surface. This intrusion has brought about the formation of the "Five Islands" (Avery, Jefferson, Weeks, Cote Blanche, and Bell), which are hills overlying the salt domes and rising some 40 to 130 feet above the surrounding marsh. These formations are found along a line bearing S 49° E and run from Lake Piegnur to East Bay near the mouth of the lower Atchafalaya River. These salt domes are capped by Pleistocene and older material.

4. Coastal Texas

a. Geologic History

During one or more of the last Pleistocene interglacial periods, while glaciation had again diminished

and sea level was about at the present level, large rivers transported vast amounts of suspended mud and bottom-load sand from remote areas of Texas to deltas along broad embayments in the ancient Gulf shoreline (Fisher et. al., 1972). Late Pleistocene meandering streams, in the vicinity of the coast, became relatively straight to slightly sinuous delta distributary streams that extended across broad low deltaic plains. Sand and mud deposited at the mouth slowly extended the delta lobe into broad embayments, building land at the expense of the ancient Gulf embayment. Gulf currents and shifting distributary courses served to redistribute some sediment over wide expanses but most sediment compacted and subsided beneath the advancing delta.

Fisher et. al. (1972) explain that as pleistocene deltas built seaward, they encountered long low, narrow barrier islands or strand plain sand bodies, much like the present barrier islands. The ancient barrier-strand plain deposits are composed of shore-face sand and silt and thin, well-sorted beach sands. From Smith Point northeastward toward the Port-Arthur area, large expanses of the ancient barrier-strand plain deposits are still exposed.

Continuing with the account given by Fisher et. al. (1972), with the last rise in sea level at the end of the last glacial

episode, unfilled parts of the Trinity and San Jacinto Valleys were drowned by marine waters, producing estuaries known as Trinity and Galveston Bays. East Bay and West Bay developed as elongate lagoons, behind Bolivar Peninsula, which grew southwestward by spit deposition and shoreface deposition from eroded deltaic headlands near High Island, and behind Galveston and Follets Islands, which developed as coalescing, exposed offshore bars that grew seaward by shoreface deposition.

Sabine Lake is presumed to have developed from an ancient open bay into which the Sabine and Neches Rivers dumped their sediment loads. Much deposition took place within the bay, but because of the relatively high rate of stream discharge, large amounts of clastic materials were carried out of the bay and deposited and reworked into a mud flat-chenier plain, leaving only Sabine Pass as a channel of communication between Sabine Lake and the Gulf.

b. Geomorphology 1/

The major recent fluvial systems of the upper Texas coast include the Neches-Sabine Rivers-Sabine Lake and Pass, and the Trinity, San Jacinto, and Brazos Rivers. The Sabine, Neches, Trinity, and San Jacinto Rivers have developed

1/ From Fisher et. al. (1972).

in entrenched or incised valleys; the Brazos does not occur within an entrenched valley but flows at approximately the same elevation as the surrounding coastal uplands.

Only two river systems are currently contributing to shoreline accretion and deposition along the upper Texas coast. The Brazos River, near Freeport, which is actively building a delta and the Sabine-Neches system, which is involved in the development of the chenier-mud flat system as described above.

Fluvial-deltaic environments include the following: meander belt sands, flood basin muds, undifferentiated fluvial sands and muds, abandoned channels, point bars, levee deposit, headward-eroding streams, lakes such as Lake Charlotte, Cotton Lake, and Lake Anahuac, vegetated and unvegetated levees, fresh, brackish, and salt marshes, abandoned berms and beach-ridges, bay-margin sands and mud.

A major and very natural system along the upper Texas coast is the barrier-strand plain-chenier system. This system has its origin at the interface of the land and ocean, as described in the discussion of coastal Louisiana. Extending landward from the shoreline, the main components of the barrier-strand plain system are (1) barren beaches consisting of sand and shell; (2)

beachridge and barrier flat, consisting of grass-covered sand ridges and swales (commonly floored with fresh-to-brackish-water marshes); (3) wind-tidal flats, predominantly bare sand occurring between the backside of the barriers; and (4) salt marsh, with sparse to dense growth of salt-tolerant plants and inundated almost daily by astronomical tides. In places, sand-tidal flats and back-barrier beaches may develop on the bay side of the barrier. Other components of the barrier system are washover channels and fans and others comprising the tidal inlet, tidal delta, and accretionary spits.

The lower parts of the coastal areas and river valleys, generally at elevations less than 5 feet above sea level, support an extensive wetland-marsh system along the upper Texas coast. These areas are associated with and developed upon a variety of land forms including (1) flood-tidal deltas, (2) back sides of barrier islands and peninsulas, (3) mainland shoreline, (4) bayhead deltas, (5) abandoned tidal creeks and washover channels, (6) flood plains of major fluvial systems, (7) abandoned coarses and cut-offs of present and inactive stream systems, and (8) mud flat-chenier plains. Components of the wetland-marsh system include (1) closed brackish marsh, (2) salt-water marsh, (3) fresh-to-brackish-water marsh, coastal lakes and ponds, (5) fresh-water marsh, (6) tidal mud flats, and (7) swamp (chiefly wooded vegetation).

B. The Climate of Coastal Texas and Louisiana, and
Adjacent Gulf Waters 1/

1. General Climatology and Seasonal Weather Patterns

The following air masses either influence or control the weather in the northwestern Gulf of Mexico.

Tropical Maritime (Tm): This air mass enters South Texas from the south and southeast, as a result of the circulation around the Azores-Bermuda high pressure cell. During the period March through October, Tm air predominates at low levels across all of South Texas and the adjacent Gulf. From May through September, Tm air dominates the area almost completely. Overrunning of polar air by tropical maritime in the winter season is a common occurrence. This situation almost always results in stratus clouds with accompanying low ceilings and visibilities.

Polar Continental (Pc): This air mass rarely pushes into the northwestern gulf before October or after April, but is frequent during the winter and early spring months. It undergoes rapid modification in the area. When this air mass pushes out over the Gulf of Mexico, the return flow of modified Pc and Tm air almost always produces low stratus clouds over adjacent land areas.

1/ Information sources: Leipper (1954), Louisiana Wildlife and Fisheries Commission (1971), and Orton (1964).

Polar Maritime (Pm): This air mass is most frequent during the fall and during spring. It is rapidly modified, and the return flow of Pm and Tm air from the Gulf also results in extensive stratus formation over adjacent land areas. Overrunning by Tm air is not as frequent as with the Pc air mass. The small migratory highs of either Pm or Pc air that move down from the continental land mass result in clear skies, no fog, and little or no turbulence.

a. Winter

The northwestern Gulf of Mexico is a winter spawning ground for cyclones, which form in association with quasi-stationary cold fronts, especially Pc types. Low pressure systems usually develop on the front near the Texas or Mexican coast in association, with a trough moving eastward from southern Arizona. These waves usually travel eastward rapidly, once movement begins, but in the development stage, low ceilings and continuous rain persist for 24 hours or longer. The principal track of the associated low centers parallels the Gulf Coast before passing across northern Florida or southern Georgia into the Atlantic. Major development of the low center into a dangerous extratropical storm ordinarily does not occur until the system reaches the Atlantic.

Fair weather in the northwestern Gulf is confined largely to the closed centers of rapidly moving (eastward or southeastward) high pressure cells that pass directly over the area. This limits the duration of fair weather to about 36 to 48 hours during the winter season.

b. Spring

During March, Pc fronts usually become quasi-stationary farther north than in February, so that the principal track of low centers lies just inland along the northern Gulf Coast. However, quasi-stationary fronts continue to frequent the northern Gulf region and cause persistent periods of low ceilings and rain lasting 24 hours or longer. Fair weather is still largely associated with the closed centers of migratory anti-cyclones.

Cold fronts enter the Gulf much less frequently in April and almost never in May, so that frontal weather become less of a problem than in winter and early spring months.

The semi-permanent subtropical anti-cyclone is well established over the South Atlantic in May. Westerly systems are too weak to penetrate the strong ridge of high pressure extending westward across the Gulf of Mexico, and the season is too early

for easterly systems to exert an important influence on the weather; consequently, May can be considered as having the fairest weather of the year.

c. Summer

Easterly circulation is predominant in June so that easterly disturbances and occasionally more intense tropical disturbances begin to appear in the Gulf of Mexico during this month.

There are no significant differences in the number of tropical disturbances, amount of cloud cover, or visibility between June and July. Because of warmer sea surface temperatures, air mass thundershowers activity increases during the period from early morning to early evening.

The Azores-Bermuda high is very strong during July and August and dominates the weather pattern over the Gulf as discussed earlier.

Easterly disturbances and tropical storms in the Gulf of Mexico increase significantly in August and reach a peak in September. Tropical storms follow two principal paths into the Gulf during August, one through the Straits of Florida, the other through the Yucatan Channel. Thundershower activity is slightly more frequent than in July, and occurs mainly from early morning to mid-afternoon.

d. Fall

The July-August weather pattern just discussed continues on through September. Easterly disturbances and tropical storms reach their peak frequencies during this month. Thundershower activity decreases from the August frequency and occurs earlier in the day.

October is the transitional month, when easterly systems weaken, and westerly systems are not yet strong enough to reach the Gulf with any regularity. Continental air masses, usually of the Pm type, may occasionally move over the Gulf and produce several days of nearly cloudless skies. Tropical disturbances may still enter the Gulf during October, but their frequency in the northwestern Gulf is about one-half of September's. Very few thunderstorms occur in October.

Tropical storms seldom enter the Gulf of Mexico during November. Subtropical anti-cyclones over the South Atlantic are migratory and westerly systems control the weather in the Gulf and adjacent land areas.

2. Sky Cover and Visibility - Seasonal Variations

a. Winter

Cloud cover over the northwestern Gulf of Mexico is two tenths or less approximately 30 percent of the time, and

eight tenths or more about 40 percent of the time. Visibilities less than five nautical miles (M) are slightly more frequent in January and February than in December because of more frequent fogs induced by colder water temperatures, and are also more frequent in the coastal waters than in the central Gulf area for the same reason. In coastal waters, visibilities of less than five M are reported in about 15 percent of ship observations during January and February, compared to 10 percent in waters further offshore. During December, a visibility of less than five M is reported about 10 percent of the time with less geographic variation.

b. Spring

Considerable cloudiness persists through April, but breaks off sharply in May. Sky cover of two tenths or less occurs approximately 30 percent of the time. In May, two tenths or less sky cover is reported about 30 percent of the time, but the percentage frequency of cloud cover eight tenths or more decreases to only 20 percent. Visibilities improve sharply in April, compared to March, as the sea surface temperatures rise. Frequency of visibilities less than five M is 10 percent in March and five percent in April in the northwestern gulf. During May, restrictions to visibilities rarely occur except possibly under infrequent thundershowers.

c. Summer

The frequency of sky cover two tenths or less over the northwestern Gulf Coast is about 30 percent, and the frequency of sky cover eight tenths or more is about 20 percent. No restriction to visibility occurs except in heavy rainshowers.

d. Fall

September visibilities and sky cover are similar to those present in summer. During October and most of November, cloud cover two tenths or less is reported by approximately 50 percent of the ship observations off the middle and upper Texas Coast, and the Louisiana Coast. Farther offshore, the frequency of cloud cover eight tenths or more is about 30 percent. Advection and frontal fogs begin to appear in November, reducing the visibility to less than 5 M about 10 percent of the time near the coast and about 5 percent of the time farther offshore.

3. Surface Wind Patterns

The Azores-Bermuda atmospheric high pressure cell dominates the circulation over the Gulf, particularly during the spring and summer months. In late summer there is a general northward shift of the circulation and the Gulf comes under the more direct influence of the equatorial low pressure belt. During the relatively constant summer conditions, the southerly

position of the Azores-Bermuda cell brings about predominance of southeasterly winds. The winds tend to become more southerly in the northern part of the Gulf. Typical summer and winter circulation patterns are shown in Figures 5 and 6.

During winter, winds usually blow from easterly directions with fewer southerlies but more northerlies. Winds from west and southwest are rare anytime during the year.



GENERAL CIRCULATION PATTERNS OF THE GULF OF MEXICO
The circulation patterns shown in this figure are based on the
analysis of the wind data for the period 1950-1959. The
patterns are shown for the summer (June-September) and
winter (December-March) seasons. The summer pattern is
characterized by a strong flow from the east and south
towards the west and north. The winter pattern is
characterized by a weaker flow from the east and south
towards the west and north. The patterns are shown for
the Gulf of Mexico and the surrounding landmasses.

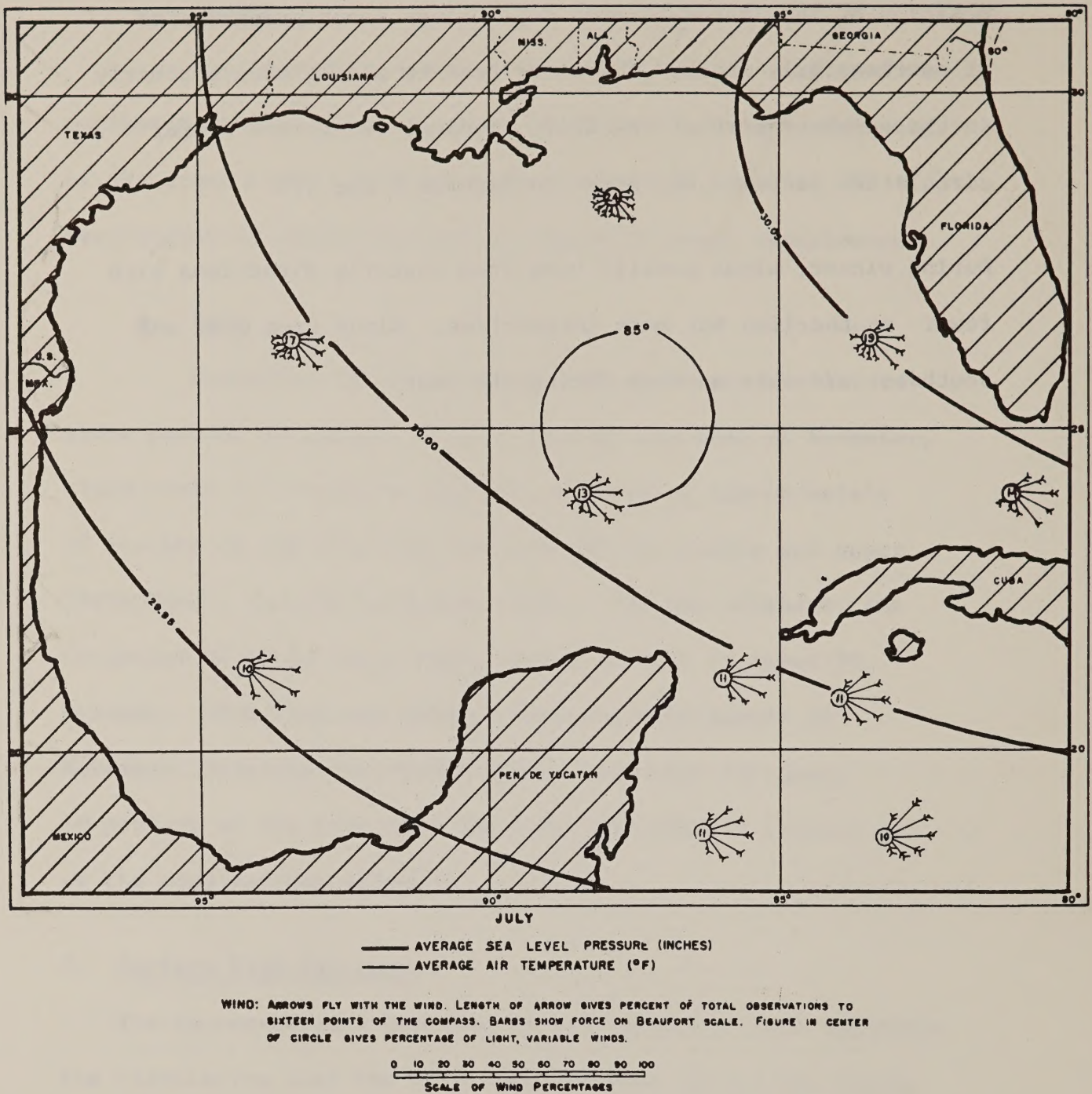


Figure 5. Average Atmospheric Conditions over the Gulf of Mexico in July (from Leipper, 1954).

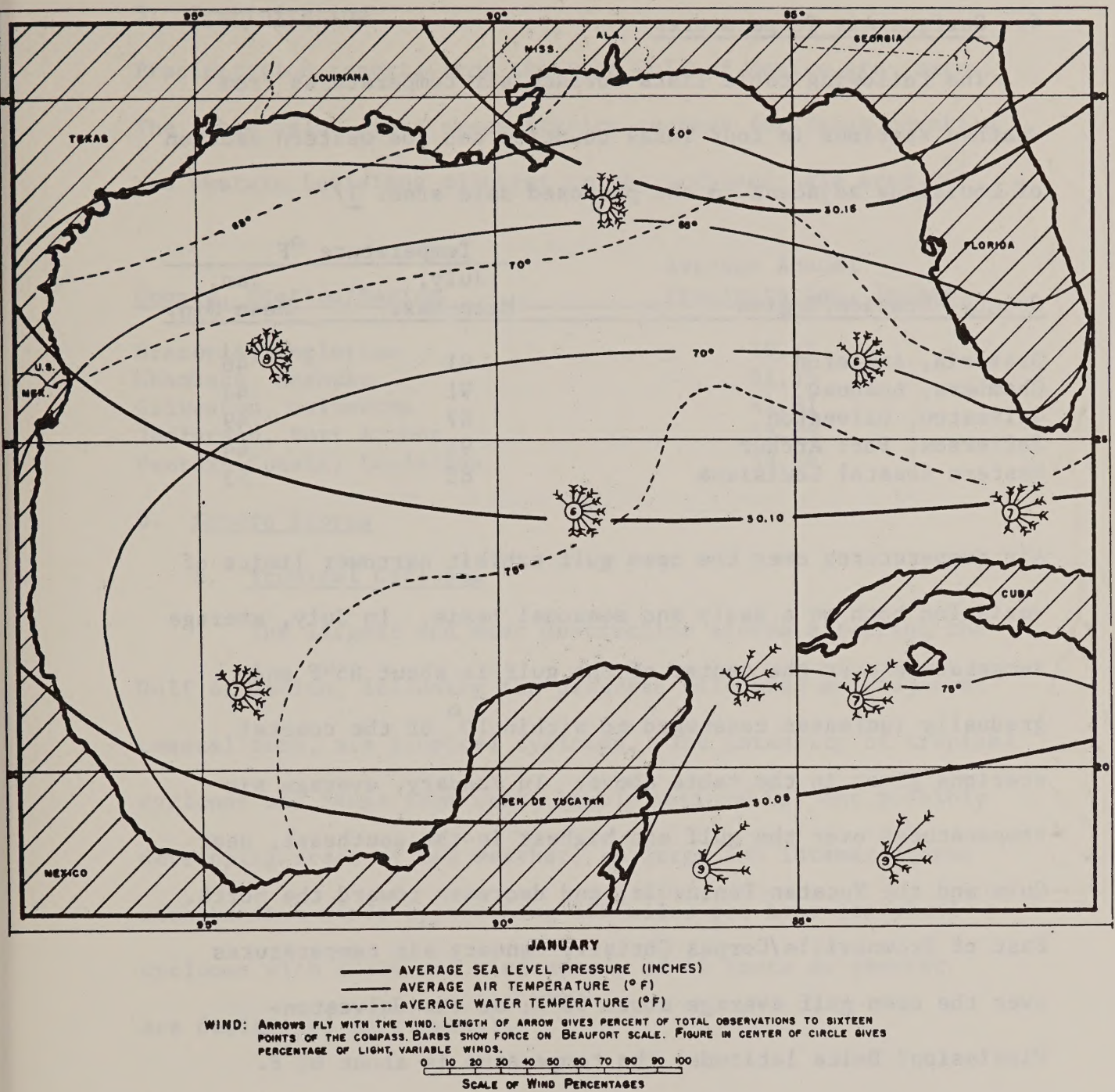


Figure 6. Average Atmospheric Conditions over the Gulf of Mexico in January (from Leipper, 1954).

4. Surface Air Temperatures

The following table lists surface air temperatures from weather stations in four Texas counties and the western section of Louisiana adjacent to the proposed sale area. 1/

<u>County, Station/Region</u>	<u>Temperature °F</u>	
	<u>July,</u> <u>Mean Max.</u>	<u>Jan.</u> <u>Mean Min.</u>
Brazoria, Angleton	91	46
Chambers, Anahuac	91	44
Galveston, Galveston	87	49
Jefferson, Port Arthur	91	44
Western coastal Louisiana	82	53

Air temperatures over the open gulf exhibit narrower limits of variation both on a daily and seasonal basis. In July, average temperature over the center of the gulf is about 85°F and gradually increases coastward to within 10° of the coastal stations given in the table above. In January, average air temperatures over the gulf are highest in the southeast, near Cuba and the Yucatan Peninsula, and decrease toward the north. East of Brownsville/Corpus Christi, January air temperatures over the open gulf average about 65°F; at the Galveston-Mississippi Delta latitude, the temperature is about 60°F.

1/ Texas reports are from Moore (1972).

5. Precipitation

Precipitation reports from the open Gulf of Mexico are rare. The table below lists precipitation records for Texas counties and western Louisiana adjacent to the proposed sale area. ^{1/}

<u>County, Station/Region</u>	<u>Average Annual Precipitation, Inches</u>
Brazoria, Angletion	49.16
Chambers, Anahuac	51.55
Galveston, Galveston	41.81
Jefferson, Port Arthur	53.09
Western Coastal Louisiana	58.26

6. Severe Storms

a. Tropical Cyclones

The largest and most destructive storms affecting the Gulf of Mexico, including the proposed sale area and adjacent coastal zone, are tropical cyclones. The intensity of tropical cyclones may range from weak, barely noticeable but possibly developing areas of bad weather, to large and intense storms with maximum winds approaching 200 miles per hour (tropical cyclones with sustained wind speeds of 64 knots or greater are designated hurricanes).

All tropical cyclones which may affect the proposed sale area may be expected to originate within the Gulf of Mexico, the Caribbean Sea, or the southern part of the North Atlantic Ocean. The storm season extends from June to October with

^{1/} National Oceanic and Atmospheric Administration weather station records, p. 129 - 130 from Moore (1972).

the greatest number occurring in August and September. During an average year, off the Gulf and Atlantic Coasts, there are fewer than ten tropical cyclones, of which about six develop into hurricanes. Over the last 10 years, these caused in an average year, the death of 50 persons between Texas and Maine, and property damage exceeding \$400 million.

Hurricanes vary considerably in intensity, track patterns, and behavior upon crossing land, but several processes and their effects are common to all hurricanes. McGowen, et. al., (1970), in describing these processes explains that the storm approach is marked by rising tides and increased wind velocities; generally the longer a storm lingers in the gulf, the larger the bulge of water it pushes ashore as it approaches land. These storm tides are commonly higher in the bays than on gulf sea beaches, although flooding and pounding waves affect both areas. Hurricane Carla, in 1961, produced 22-foot tides in Lavaca Bay, Texas; Hurricane Celia, in 1970, produced 14-foot tides in Corpus Christ Bay, Texas; Hurricane Camille, in 1969, produced 22.6 foot - tides at Pass Christian, Mississippi.

The flood tides and high waves carry shells and sediments from deeper offshore areas onto seaward beaches, spreading a veneer of deposits over the broad, flat hurricane beaches. In the marsh areas, extensive and prolonged inundation and pounding result, with damage or loss to habitat and man-made structures within. The storm surge flood may also produce breaches or channels in natural barrier islands or in levees.

As the storm passes over the shore, the pattern of current and wave attack shifts into compliance with the direct influence of the counter-clockwise winds of the hurricane. Water and sediment are pumped out of bays and flooded areas into the gulf through passes and breaches on the left side while still being pushed shoreward or landward on the right side. The highest intensity winds are felt as the storm comes ashore, and in the vicinity of the eye, rapid changes in atmospheric pressure and the change in wind direction as the eye passes produce great stresses on structures.

No account of the effect of hurricanes on the offshore oil industry could be found for the proposed sale area, primarily because of the relatively few installations and low level of offshore drilling and production in this area. However, on August 17, 1969, Hurricane Camille passed along the eastern flank of the Mississippi Gulf Coast, passing through an area of extensive offshore activity. An account of that storm and its effects on the offshore oil industry, as described in a U.S. Army Corps of Engineers report (U.S. Army, 1970), is summarized below.

Camille's top winds were estimated at 201.5 miles per hour, and the barometric pressure in her calm eye dropped as low as 26.61 inches of mercury. The hurricane surge at Pass Christian, Mississippi, was recorded at 22.6 feet above the normal level of the Gulf. Offshore installations in areas near South Pass, Maine Pass, and Breton Sound were badly damaged. Prior to arrival of the storm, the Offshore Operators Committee advised tapering off production operations, and before the storm hit, 4,000 wells in State and Federal waters were shut-in and 3,000 workmen evacuated. Because of this caution, no injuries to petroleum production

personnel were reported and there was a total absence of blowing wells and few leaking wells. The U. S. Geological Survey reported no oil slicks in Federal waters and only one in State waters.

During the onslaught of Camille, one production platform was destroyed and two were damaged, two drilling rigs were destroyed, and three were damaged. Also in the area were seven drilling rigs that were not damaged.

When the Weather Bureau advises that a hurricane or serious tropical storm is imminent, all oil and gas facilities in or adjacent to the path of the storm are evacuated. Upon evacuation, all surface equipment and wellhead controls are shut-in. In addition, blank tubing plugs are set in as many wells as possible to further reduce the possibility of pollution in the event the well is damaged. These tubing plugs form a seal against fluid flow.

b. Extratropical Cyclones

In addition to the tropical cyclones, extratropical cyclones that may vary greatly in intensity occur in this area primarily during the winter months. These storms have attained wind

speeds as great as 30 to 50 knots. They originate in middle and high latitudes forming on the fronts that separate different air masses. The Gulf of Mexico is an area of cyclone development during the cooler months due to the contrast in temperatures of the warm air over Gulf waters and the cold continental air over the United States. From August 1959 through April 1970, 90 such extratropical cyclones have passed within 120 miles of the Mississippi Delta Region and could possibly have affected the area.

c. Polar Outbreaks

A phenomenon known as a "norther" is quite common in the area in question during the winter months. A norther occurs when cold, polar air moves southward from the cold interior of the North American continent out over the warm waters of the Gulf. This unstable cold air mass, when heated from below, develops strong gusty northerly winds with considerable cloudiness and showers. During a typical winter as many as 30 such cold outbreaks reach the Gulf coast. The majority of these cold outbreaks, spilling out over the Gulf, produce winds in the 15-20 knot range but approximately one third of these cold outbreaks have winds over 34 knots with approximately half of these being vigorous enough to reach 48 Knots.^{1/}

^{1/} Information obtained from Deputy Assistant Secretary of Environmental Affairs, Department of Commerce.

C. Physical Oceanography

1. Sea Surface Temperatures

Leipper (1954) presents figures for average February and August sea surface temperatures for the Gulf of Mexico; they are reproduced below. According to Leipper, the main feature of the average winter pattern is a gradual drop from approximately 75° F. in the south to 65° F. in the north in all parts of the gulf. In the summertime, average temperatures are very nearly uniform at 84° F. throughout the gulf. Years of investigations have shown that considerable deviation from these average isotherms may occur at certain times. It is well known that periodically, intense cold spells along the Texas coast can cause sufficient cooling of coastal waters to result in extensive mortality of warm-water fish with narrow limits of temperature tolerance (Gunter and Hildebrand, 1951).

In shallow coastal waters and in estuarine and marsh areas, water temperatures approximately follow air temperatures without reaching the extreme limits exhibited by air temperatures during brief periods.

2. Salinity

In the upper 50 meters (168 ft.), water in the coastal Gulf of Mexico typically has a salinity of very near 36.0 parts

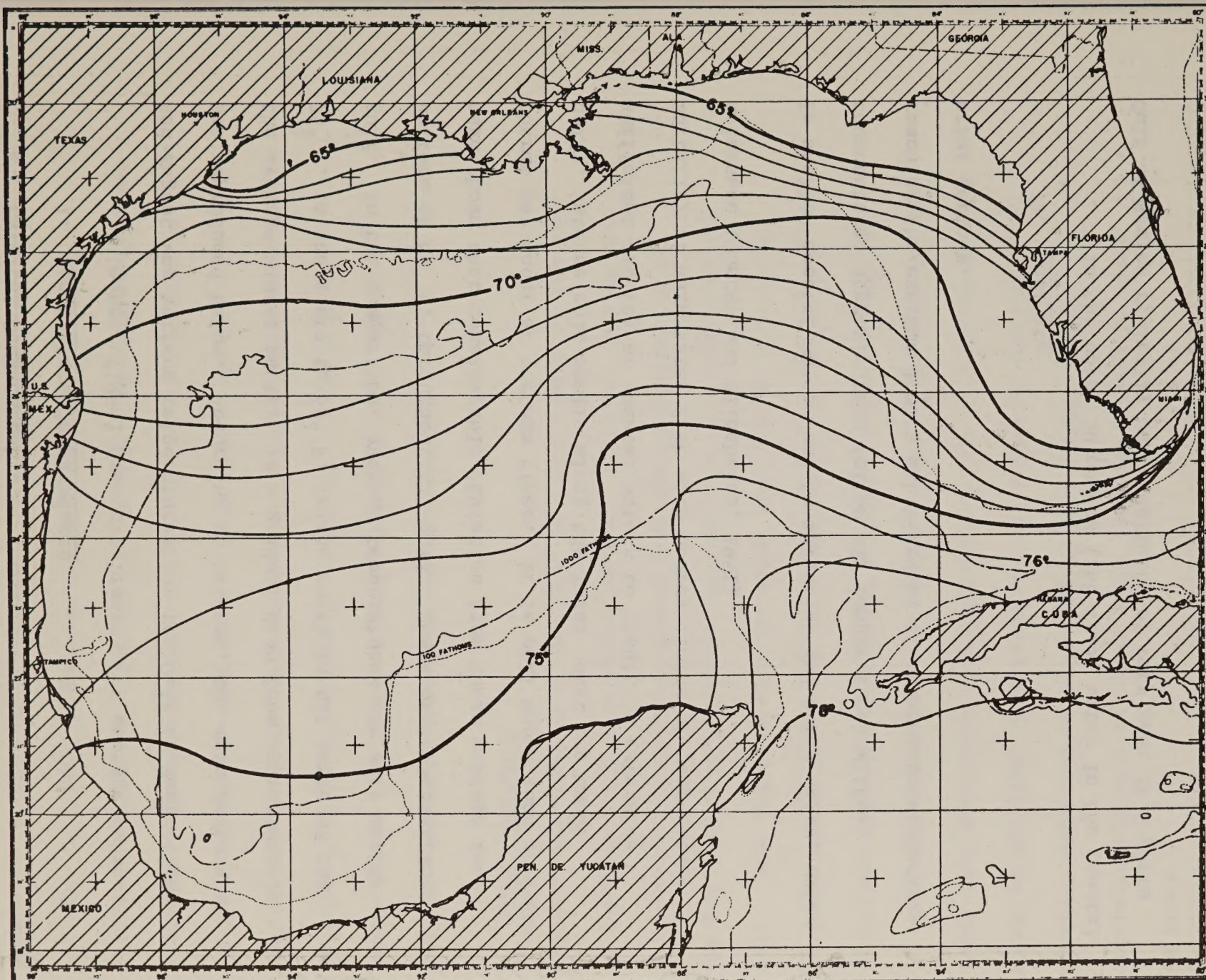


FIGURE 7.—Average sea surface temperatures for February (after Fuglister).
(from Leipper, 1954)

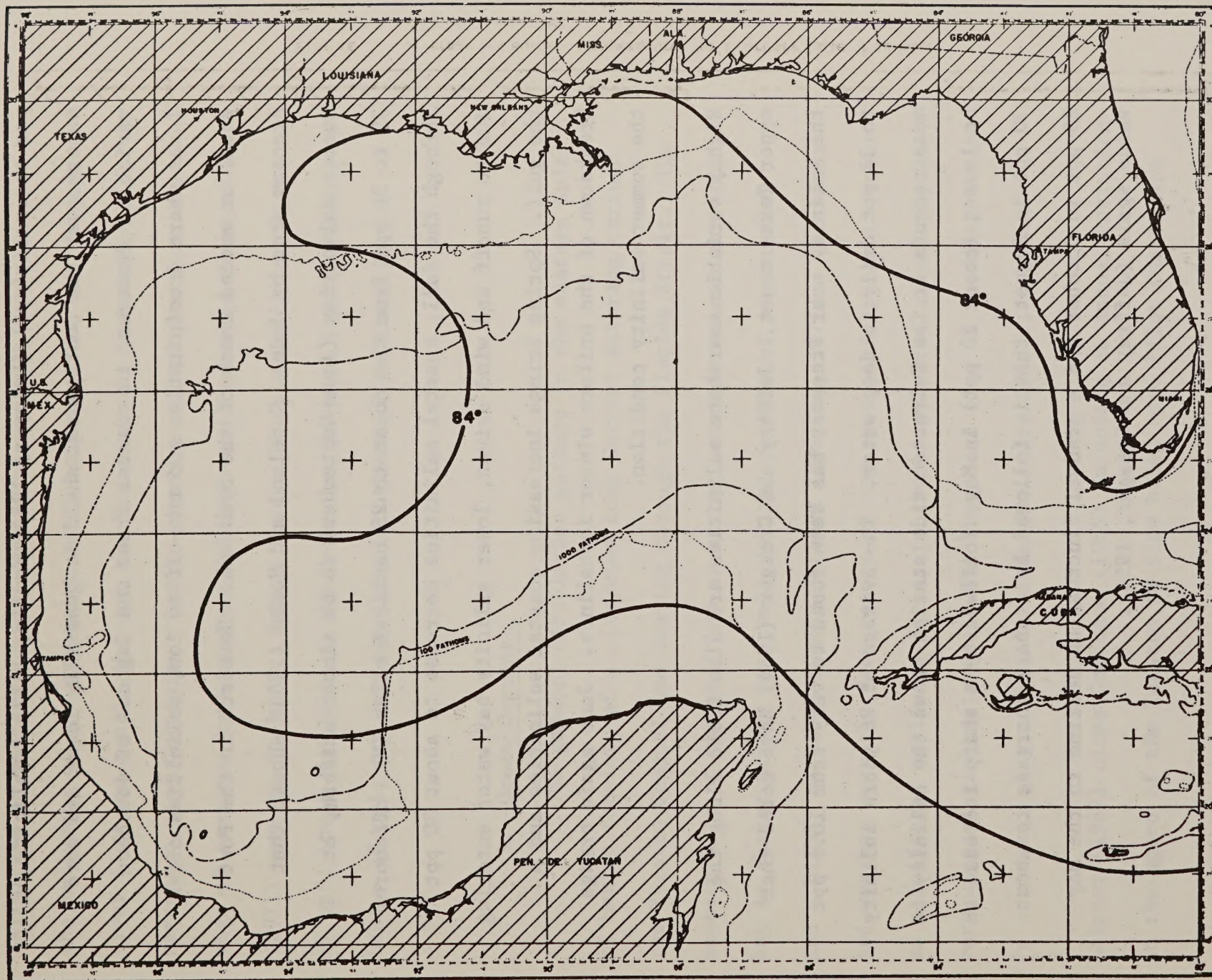


FIGURE 8.—Average sea surface temperatures for August (after Fuglister).
(from Leipper, 1954)

per thousand (ppt) (Leipper, 1954; Nowlin, 1972). Salinity of waters over the continental shelf is generally lower and more variable. However, in coastal areas and lagoons of southern Texas where precipitation and run-off is low, salinities often equal or exceed those of the open sea. Research in the Port Aransas area by Jones, Copeland and Hoese (1964) showed that summer salinities (June-September) to be almost uniform, at 35 to 36 ppt from the coast to 25 nautical miles (M) offshore. Through the fall, coastal salinities decrease to about 30 ppt due to runoff and wind driven, lower salinity bay water entering the gulf. Spring brings increasing coastal salinities and a breakdown of the uniform winter isohalines. June again brings the summer salinity condition.

Highly variable nearshore salinities are also found along the upper Texas coast. Jeffery and Creager (1954) have noted that the salinity near Freeport has been found to vary from 10.5 ppt to 34 ppt daily in deep water. The average of 26 years salinity measurements at the Galveston tide station shows the salinity to be lowest (about 20 ppt) in May, followed by a sharp increase to 30 ppt in August; this is followed by a sharp increase to about 25 ppt in October and a gradual fluctuating decline to the May value again (Jeffrey and Creager, 1954).

Salinities in western coastal Louisiana are much lower due to the influence of the extensive marsh bordering the sea, higher river flow and runoff through the Mississippi, Atchafalaya, Mermentau, and Calcasien rivers. Average salinities from one year of sampling by Louisiana Wildlife and Fisheries Commission (1971) were as follows: Sabine Pass - 17 ppt; Calcasieu Pass - 17 ppt; Lower Mud Lake on the Mermentau River - 5 ppt; Miller Lake - 17 ppt; and Portage Lake (southwest Vermillion Bay) - 3 ppt.

3. Ocean Currents

The general circulation pattern in the eastern Gulf of Mexico consists of a clockwise Loop Current entering through the Yucatan Channel and leaving through the Florida Strait. The western half of the gulf has no strong, semi-permanent currents but is characterized by a well-defined pattern of winter flow and a highly variable summer pattern (Nowline, 1971). The winds and weather over the deep waters of the open gulf appear to enter as significant modifying forces to the broad circulation only in very unusual circumstances. The shape and size of the deep basin, in contrast, play a critical role (Leipper, 1967).

Leipper (1967) cites Cochrane (1965) in noting an annual variation in the speed of the Yucatan in flow based upon Pilot Chart data

and current and temperature measurements. Cochrane has found a maximum of nearly 36 miles per day in May and June, and a minimum of about 24 miles per day in October and November. Leipper notes that the current regime in the Gulf can be considered in two parts related to this variation in inflow speed. The first part which appears to exist most of the time, during the period of maximum flow, may be called the "Spring Intrusion". It is formed as a small loop close to Cuba in January and February and grows in size and extends continually farther out into the gulf until August. The second part of the flow regime may be thought of as the "Fall Spreading". This event occurs at least in some years beginning in August and September and continuing to February or March. It consists of a weakening and possibly a splitting of the loop flow and an extension of it into the western part of the gulf. This extension may occur by a splitting of the flow just north of the Yucatan Shelf and a turning westward of a portion of it, or it may occur by a westward bending of the entire north end of the loop or of an eddy derived from the loop.

Thus, in contrast to the eastern portion of the gulf, which is dominated by the major Loop Current system and occasional eddies, the western portion seems characterized by generally minor currents, such as regional winds and the Fall Spreading.

In attempting to characterize the general circulation over the deep portions of the western Gulf basin, Nowline (1971) has stated that the winter current pattern of east-west flow seems typically to be of broad westward flow through the southern part and a narrow zone of stronger eastward flow in the deep water portion of the northern Gulf. This eastward flow is separated by a strong shear zone from a narrow westward counter flow located immediately to the north, just above the continental slope. A unique summer pattern cannot be defined from existing data. It is likely that eddies drifting into the western Gulf contribute to the high degree of variability seen there in summer.

An investigation by Kimsey (1964) limited to the currents above the continental shelf of the northwestern Gulf of Mexico, involved the use of drift bottles to define the current patterns. Through the course of this study, the following seasonal patterns emerged.

During winter, surface currents over the continental shelf are along shore, westerly and southwesterly with velocities ranging from 8 to 13 miles per day. Very close to shore, a northerly countercurrent is detectable in the Brownsville and Corpus Christi, Texas areas. Velocities of the countercurrent decreased along its path from about 9 miles per day at Brownsville to 1 or 2 miles per day near Corpus Christi.

Early in spring a northeastern current begins to appear offshore and converges with the southwesterly current. This current apparently contributes to the Gulf Stream, as drift bottles released off Louisiana in the investigation cited above were carried to eastern Florida beaches. As spring progresses and winter northerly winds give way to strong southerlies, the convergence moves northeastward along the Texas coast and by late spring-early summer, surface currents are strongly onshore off central Texas and obliquely onshore (NNE) along Louisiana.

Through mid-summer surface currents over the shelf are along shore, northeasterly and easterly between Brownsville, Texas, and the Mississippi River Delta.

By the end of summer, currents are again westerly and along shore, turning to the southwest along the south Texas coast. This condition prevails throughout autumn and winter.

Kimsey concluded after studying current charts of the U.S. Naval Oceanographic Office and wind records of the U.S. Weather Bureau, that the patterns of change in surface currents over the continental shelf in the northwestern Gulf of Mexico is much the same each year. He believes that variation is a matter of timing and this, in turn, is largely a function of prevailing winds.

An illustration of the current patterns just discussed are in Figure 9 below.

4. Astronomical Tides 1/

The tide-producing forces of sun and moon change from day to day in accordance with the changing positions of those bodies relative to the earth. Hence, at any given instant the tide-producing forces are distributed over the earth in a regular manner varying with longitude and latitude. However, the response of different seas to the same set of tide-producing forces can be profoundly modified by the physiographic and hydrographic features of particular oceanic basins.

In the northwestern Gulf of Mexico three types of tides occur:

(1) Lake Pontchartrain, New Orleans, Port Eads, Louisiana; Round Point (Trinity Bay), Texas - DIURNAL TIDE. That is, one high and one low water occur in a day. An example is given in Figure 10.

(2) Weeks Bay (Vermillion Bay), Eugene Island, Louisiana; South Jetty Light (Bolivar Roads), Galveston (Bay side), Carancahua Reef in West Bay, Texas - MIXED DIURNAL TIDE. That is, during about half of the days in a fortnight, there will be essentially

1/ From a discussion by Marmer (1954).

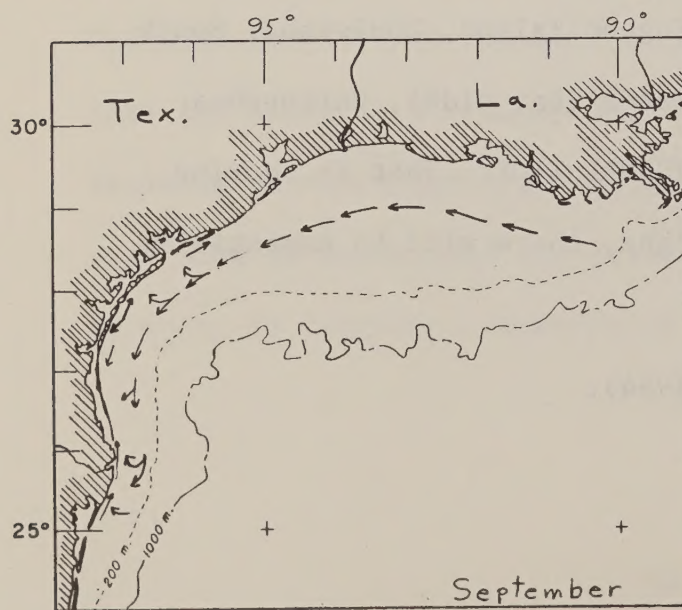
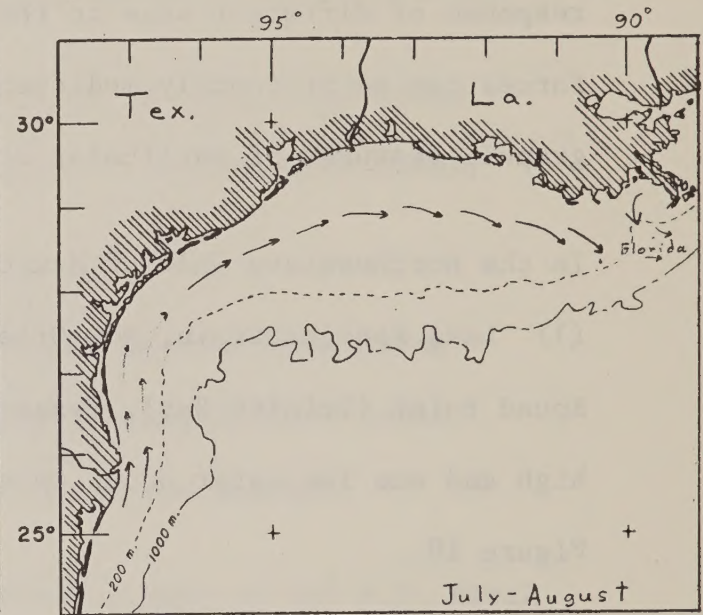
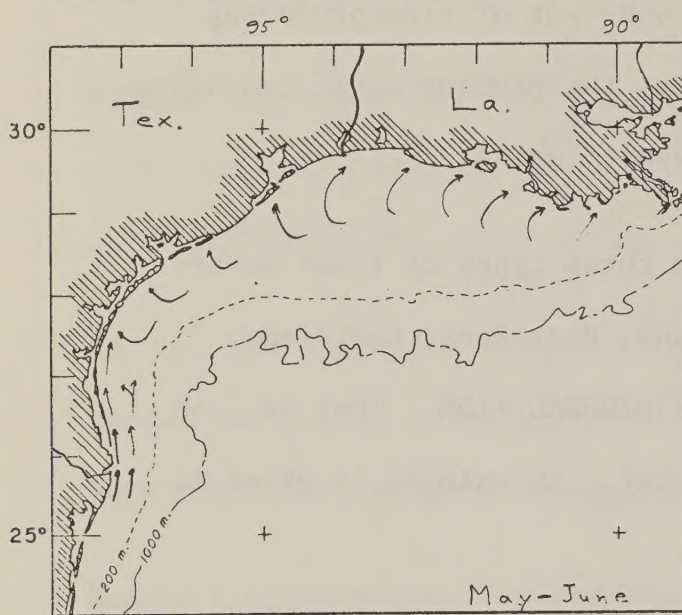
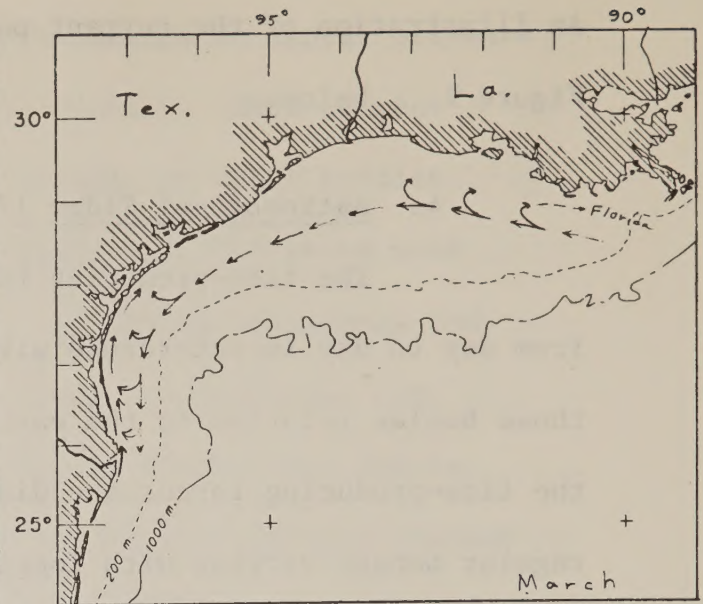
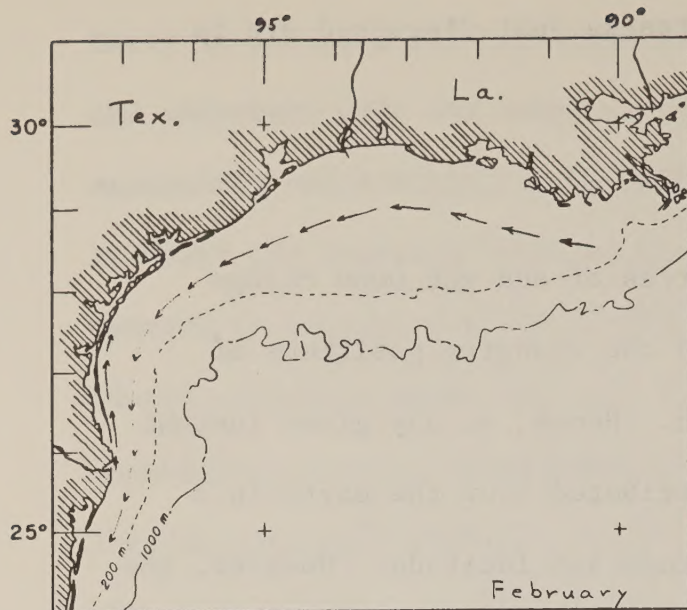


Figure 9.--Simplified current patterns in the northwestern Gulf of Mexico.
(after Kimsey, 1964)

one high and one low water per day, but during the remaining days, there will be two high waters, and two low waters per day. An example is shown in Figure 10.

(3) Calcasieu Light (Calcasieu Pass), Louisiana - MIXED SEMI-DIURNAL TIDE. That is, two high waters and two low waters occur each day, but difference between higher high water and lower high water, and between higher low water and lower low water varies daily according to a fortnightly cycle. An example is shown in Figure 10.

The regularity in the periodic rise and fall of the tide and its cyclic variation is subject to the disturbing effect of changing meteorological conditions. These disturbances are brought about by strong winds "piling up" water in a particular area or by a significant change in barometric pressure, the water surface being depressed by a high pressure area or bulging upward under a low pressure area.

In an area low tidal range such as the northwestern Gulf and its one to two foot tides, these meteorological disturbances are normally unimportant. It is only during the onslaught of an intense storm, such as a hurricane, that the normal level of the sea can be radically changed. An example is the 22.5 foot storm tide along the Mississippi coast, caused by Hurricane Camille (discussed in section II.B.6).

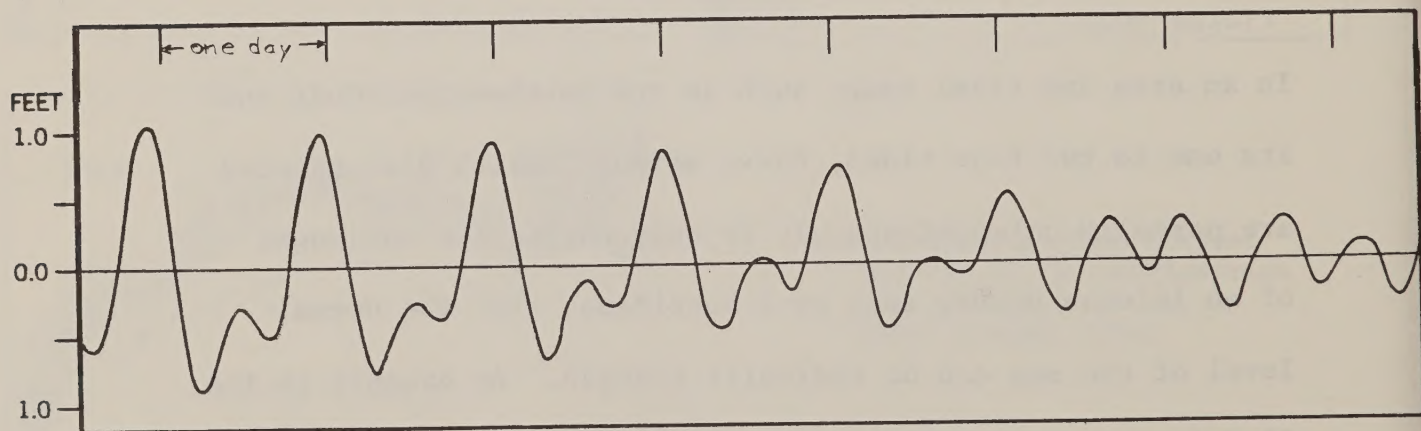
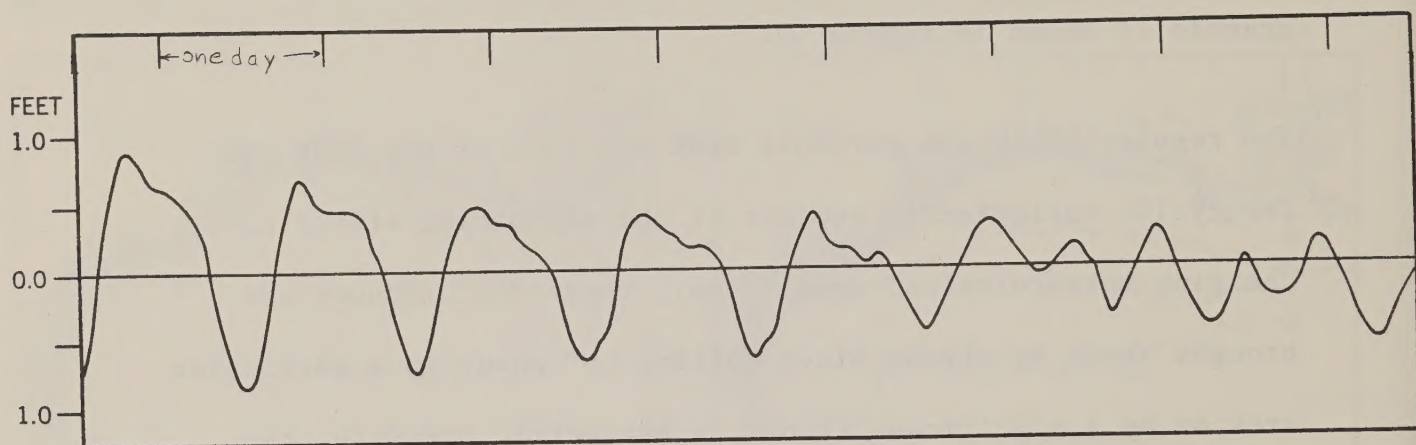
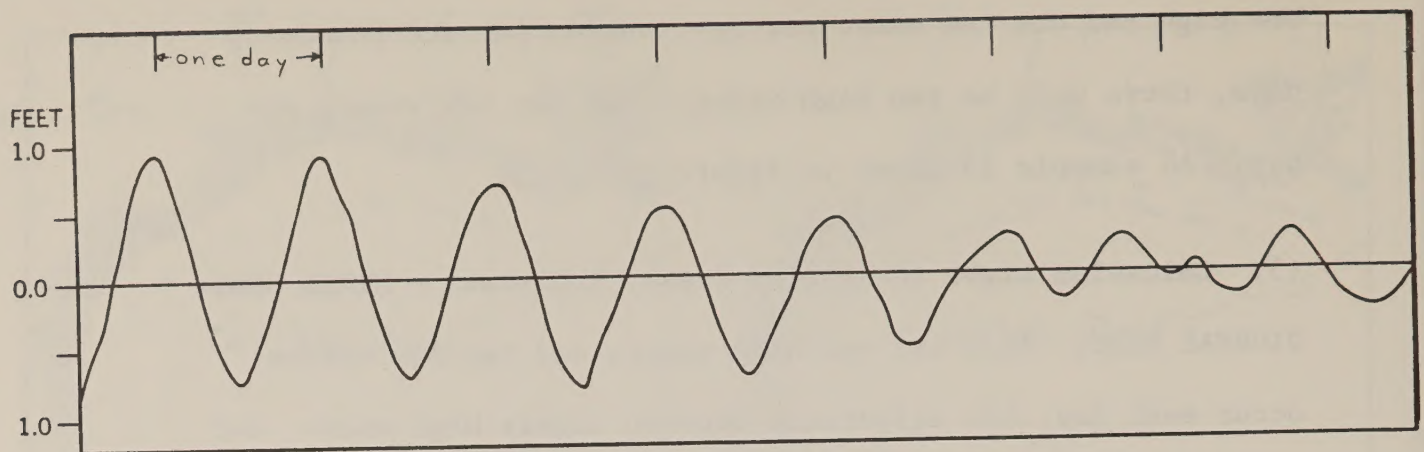


Figure 10.--Three types of tides found in the northwestern Gulf of Mexico.
a. Diurnal; b. Mixed diurnal; c. Mixed semidiurnal.
(from Marmer, 1954)

5. Ocean Wind Waves (Sea) and Swell

Both wind waves and swell are appreciably lower in the Gulf of Mexico than along the Atlantic and Pacific coasts. Jeffery and Creager (1954) noted the following characteristics about sea and swell in the Galveston-Port Arthur area. In summer, seas are low (wave heights of 1-3 ft.) on an average 70-80% of the time, and high (7-8 ft.) about 1% of the time. The swells in summer are low (1-6 ft.) at least 80% of the time and high (7-12 ft.) 0-5% of the time. During winter, seas are low only 45-68% of the time and are high 4-9% of the time.

Jeffery and Creager (1954) presented a histogram of wave height frequency, originally credited to Fleming and Bates (1952), for a point southeast of Galveston. Wave heights were calculated from sea and swell observations. That histogram is reproduced here in Figure 11.

Storm swells of considerable magnitude occur in the northwestern Gulf often enough to merit their mention. Hurricanes occur in this area mainly from June through October with July and August being the months of greatest hurricane frequency. The average life of a hurricane in the Gulf is 9 1/2 days. Jeffery and Creager (1954) state that Galveston and Port Arthur may, on the average, expect to be affected by a hurricane every seven

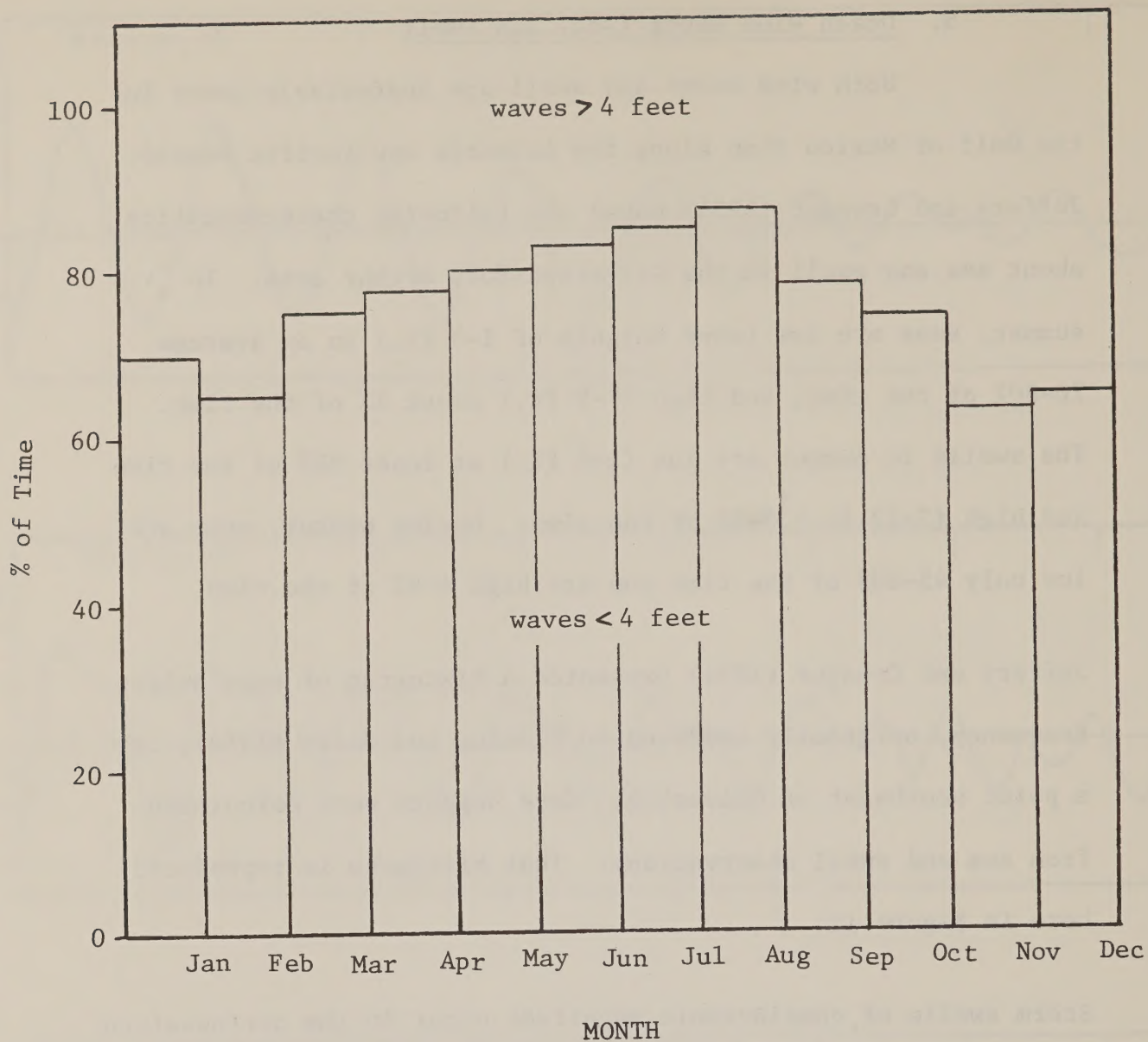


Figure 11.-- Probable frequency of occurrence of waves above and below four feet in height at a location southeast of Galveston, Texas. (from Jeffery and Creager, 1954)

years. The same authors describe the resulting sea and swell as follows:

"The swells and waves generated by a hurricane travel directly forward from the right front segment of the storm at speeds estimated to be 50-60 mph., and may precede the storm by 600 miles. Both the gradually sloping regular bottom topography of the Texas coast and low gravitational (astronomical) tides keep storm tides at or below 15 feet MSL (above mean sea level)"

D. Ecology of the Northwestern Gulf of Mexico and Adjacent Coastal Zone

The natural environment can be conveniently assigned to three natural subdivisions for purposes of discussion: the coastal zone, the neritic zone, and the oceanic zone; however, it should be kept in mind that there is periodic and continual exchange, throughflow and, interaction of many living and non-living components of these systems.

This discussion has been titled "Ecology ...", but it will indeed only touch upon the barest qualitative framework of the ecological systems under consideration. No attempt will be made to ascertain and include quantitative aspects such as rates of energy input or biomass, population dynamics, and limiting factors. The boundaries of the area to be discussed are roughly the arc of coastline from 92° to 96° west longitude and from five feet above MSL to the abyssal Gulf. Major biotopes are shown in figure 12.

1. The Coastal Zone

a. The Environment

The coastal zone includes bays, salt marshes, estuaries, barrier islands, beaches, and other shoreline features. Marshy and submerged components are characterized by low but variable salinity, and except for Galveston Bay, reduced tidal

action. Most of these biotopes receive simultaneous or intermittent inflow from both streams and from the Gulf. These conditions result in considerable sedimentary material being deposited here so that the bottoms tend to be quite muddy. Bacteria and other decay organisms break down the organic material transported from elsewhere as well as the locally produced organic material. Such areas, especially the brackish marshes, are normally zones of intense biological activity. Large populations of juvenile fish, crustaceans, and molluscs utilize these areas as nursery grounds and feed mainly upon the nutrient-rich decaying organic matter of the shallow backwaters.

The Gulf coast Prairie, according to Suter (1971), is a nearly level plain, slowly drained, and less than 150 feet in elevation, with numerous sluggish rivers, creeks, bayous and other water ways. It is characterized by level grass lands that support ranching and farming, low woodlands primarily along streams and wetlands. The climax vegetation of the Gulf Prairies is largely southern cordgrass prairie and bluestem - sacahuista prairie or post oak savannah. However, in Texas, much of the area has been invaded by trees and brush such as mesquite, oaks, prickly pear, and several acacias. Woodlands along streams and wetlands may consist of pine, willow, ash, cottonwood, live oak, bald cypress,

and others. Further discussion of this upland area will not be made because any impact from the proposed leasing action is considered to be minimal in this area. The remainder of this discussion will be restricted largely to areas below the five foot topographic contour.

b. Communities of the Coastal Zone

(1) Prairie Marsh of Western Louisiana

The following account of this area is taken primarily from O'Neil (1949). The general character of this marsh is one of shallow peat spoils ranging in depth to five or six feet. The entire marsh floor is near sea level and poorly drained which results in deep, stable water levels. All high ground in the marsh is confined to stranded ancient sea rims, or chenieres, the present day sea-rim, natural levees along rivers and bayous, and "made" land (dredging spoil piles, filled areas, etc.).

An area somewhat representative of the entire prairie marsh near the mouth of the Mermentau River has been chosen for detailed discussion here. In order to simplify the discussion, a cross-section of a transect is shown in figures 12-13. The sea-rim, region 1, is comparatively low, about two to three feet above normal high tide.

(a) Producers

Sea-rim marshes are dominated by comparatively narrow zones of various species of marsh vegetation.

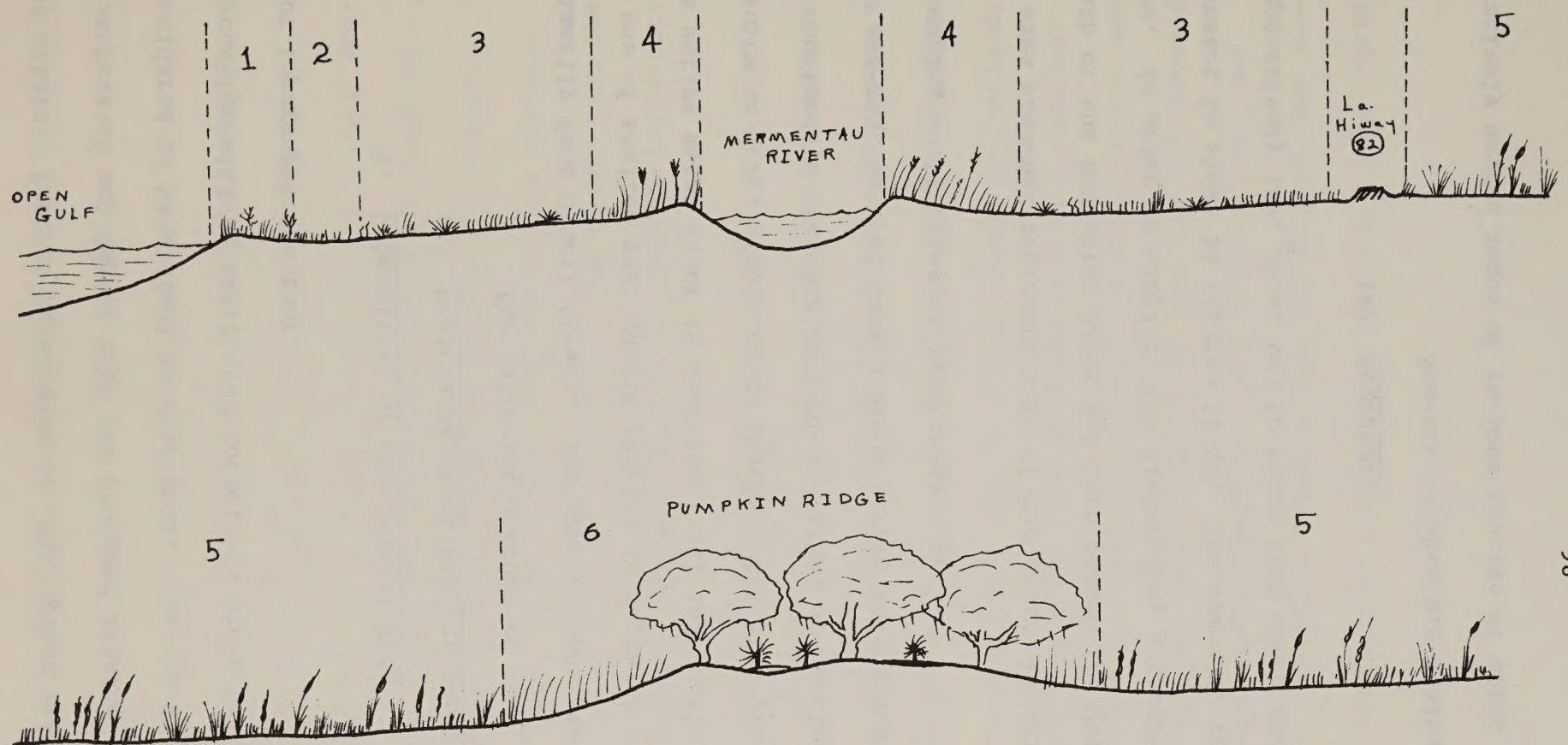


Figure 13.--Transect (a) of Figure 12: Cross-section of Prairie Marsh of Western Louisiana.

The crest is protected against wave action by growths of buckbrush (Baccharis halimifolia) associated with hogcane (Spartina cynosuroides) and oystergrass (Spartina alterniflora). Behind this is the excessively drained salt marsh, region 2, where highly saline mineral deposits have been brought ashore by each high tide. This narrow band supports a salt grass (Distichlis spicata), oystergrass, wiregrass (Spartina patens) association. The next region, numbered 3, is the brackish marsh, where the climax vegetation is wiregrass (Spartina patens). However, annual burning of the marsh during the summer dry season results in a subclimax vegetation of three-corner grass or rush (Scirpus olneyi), or coco (Scirpus robustus), which is more desirable as muskrat habitat. The natural levees and banks of bayous and the Mermentau River (region 4) in the brackish marsh are vegetated by roseau cane (Phragmites communis) and hogcane. The inner banks of bayous, and the river are populated by mud algae, usually diatoms (Chrysophyceae) and blue-green algae (Cyanophyceae), and the brackish, bayous and river waters and marshy areas where ponding has taken place have marsh grasses and phytoplankton producers. Another important group of algae is the epiphytic "slime" of filamentous green algae and diatoms growing upon the submerged stems of the marsh grasses.

Louisiana State Highway 82 apparently diminishes the free circulation of water in the marsh in this area because it roughly marks

the transition from the previously discussed brackish marsh and a fresh water marsh (region 5). The vegetational association of this marsh is of canouche (Panicum hemitomon), cattails (Thypha spp.), bull-tongue (Sagittaria lancifolia), spike rushes (Eleocharis spp.), yellow cutgrass (Zizaniopsis miliacea), saw grass (Cladium jamaicense), roseau cane, and bulrush (Scirpus californicus). Aquatic species of producers include submergents: coontail (Ceratophyllum demersum), water milfoil (Myriophyllum spicatum), pond weeds (Potamogeton spp.), and the floating duckweed (Lemna spp); and algae: filamentous floating and attached green algae, planktonic green algae, planktonic, benthic, and epiphytic diatoms, floating, epiphytic, and benthic bluegreen algae, and rare occurrences of other groups.

About four miles further inland, through the freshwater marsh, the next region (no. 6) is a chenier, Pumpkin Ridge. As stated earlier, chenieres are ancient sea-rims that were stranded behind an advancing shoreline. Along with natural and artificial levees, and the modern sea-rim, they are the only elevated, relatively dry areas in the marsh. Chenier vegetation consists of short-meadow-like grasses and forbes with live oak (Quercus virginiana) and dwarf palmetto (Sabal minor) dominating the view. Beyond the chenier, the fresh water marsh continues.

(b) Consumers--Divergent Food Chains

Odum (1961) cited studies which showed that less than 5% of net production of marsh grass (Spartina) is consumed "on the stalk" by insects and other grazers. Most of the marsh primary production is channeled through the detritus food chain. (As grass dies and falls into the water, the abundant microorganisms convert it into particles rich in bacterial and algal growth and containing abundant proteins, carbohydrates, and vitamins.) Thus, whether marsh production is finally channeled into predatory fish, hawks and owls, alligators, or human food stuff, nearly all of it passes from marsh grass through the detrital food chain and then upwards.

In the brackish river, bayous, and ponds, sampling by the Louisiana Wildlife and Fisheries Commission (1971) indicates the primary aquatic consumers are largely comprised of a few species of copepods (mostly Acartia tonsa, plus Labidocera aestiva, Centropages sp, Corycaeus sp., Eurytemora sp., and Tortanus sp.) and a few other members of the zooplankton such as Oikopleura sp. These animals and others are also involved in the detrital food chain, as they normally include both particulate organic matter plus living phytoplankton in their diet. Other organisms feeding partly to largely on detritus are clams, various worms (Annelida:Polychaeta: Sedentaria, nemitodes, turbellarian flatworms), crabs, grass shrimp and amphipods.

Preying on the planktonic herbivores and detritus, feeders are various jelly fish, comb jellies (ctenophores) arrow worms (chaetognaths), larval and juvenile decapod crustaceans (blue crabs, white, and brown shrimps), grass shrimp, larval fish of many species, small predatory fish (especially the tidewater silver sides, Menidia beryllina and bay anchovy, Anchoa mitchilli), and the filter feeding fish, especially the menhaden (Brevoortia patronus).

In the position of secondary and tertiary aquatic consumers and perhaps even higher are the predatory fishes and larger invertebrates. Louisiana Wildlife and Fisheries Commission (1971) has found 43 species of fish and large swimming or crawling invertebrates by trawling and seining surveys of which, most belong here in the food chain. Quantitatively, the more important species are the sand weakfish (Cynoscion arenarius), spot (Leiostomus xanthurus), atlantic croaker (Micropogon undulatus), mullet (Mugil cephalus), adult white and brown shrimp (Penaeus setiferus and P. aztecus), and blue crabs (Callinectes sapidus). This is an over-simplification, however, because some species are quite omnivorous, such as the spot, which was found by Parker (1971) to feed upon detritus, vascular plants, algae, other fish, protozoans, worms, snails, clams, insects, barnacles, shrimp, zooplankton, and

hydroids. These types of animals may not strictly be assigned to a given trophic level. These trophic labels of convenience cannot be strictly applied to each species.

Curl and Small (unpublished manuscript) have aptly stated:

"For the most part we do not find simple food chains, each link leading to a higher trophic level organism. Instead, we find food webs in which it is difficult to find all of the links or to assign them to particular levels. The concept of trophic levels is a useful simplifying assumption, however, and permits a consideration of the cyclic flow of energy and elements in ecosystems."

Non-aquatic or semi-aquatic consumers include many species of water fowl, shorebirds, predaceous diving birds, muskrats, raccoons, alligators, nutria, rabbits, deer, frogs, snakes, turtles, mink, and wild hogs. Most waterfowl feed by browsing on vegetation and straining small organisms and detritus from the bottom muds. A few have bills equipped for catching small fish, shrimp, and other small swimming animals. The shorebirds, coots, rails, and gallinules, are mostly browsers, but many feeding habits are represented. The herons and relatives are mostly wading fish-eaters. Mink, hawks, and owls prey upon nutria, muskrat, rabbits, and other small animals. Frogs and snakes are strictly predaceous. Turtles are browsers and predaceous. Nutria and muskrats are largely browsers but will take insects, clams, and fish if convenient. Alligators, raccoons, and wild hogs are quite omnivorous, but raccoons tend not to be predatory, except on insects, fish, and shellfish. Only deer and rabbits are strictly phytophagous grazers.

All of the above except the rabbits, deer, hawks and owls, raccoons and wild hogs belong essentially to the open marsh community. Only the feeding activities of the latter group constitute an interaction with strictly aquatic community in the river, bayous and ponds.

Only deer, rabbits, many insects and a few species of snakes, frogs, turtles, the hawks and owls, and small perching birds belong to the minor dry land chenier community. The modern sea-rim probably doesn't constitute a community because members of most trophic levels spend parts of the life cycles elsewhere or are merely casual feeders.

(2) Strand Plain Chenier Marsh of the North-eastern Coast of Texas 1/

The second section of northwestern Gulf of Mexico coastal zone to be discussed is that stretching from the eastern end of East Bay (Galveston Bay) to the vicinity of the 94° west meridian near the edge of the Sabine Pass-associated chenier-mud flats. A "typical" transect (No. 2 of figure 12) is shown in figure 14.

This area differs from the Mermentau River transect of Louisiana in several ways. The marsh is not nearly so extensive, about 4 miles wide as compared to 25 or 30 in Louisiana. The sea rim contains an extensive fore beach, foredune ridge, and sandy strand plain flat, most of which rise to over five feet above sea level. The marsh behind is either brackish or salt, and the supply of fresh water is less.

(a) Primary Producers

The beach, region 1, is mostly barren, but may have sea oats (Uniola paniculata) and other halophytes present.

Behind this region is the vegetated strand plain flat. It contains three subregions based upon elevation, exposure to wind

1/ Information for this section is largely from Fisher et. al., (1972), Jeffery and Creager (1954).

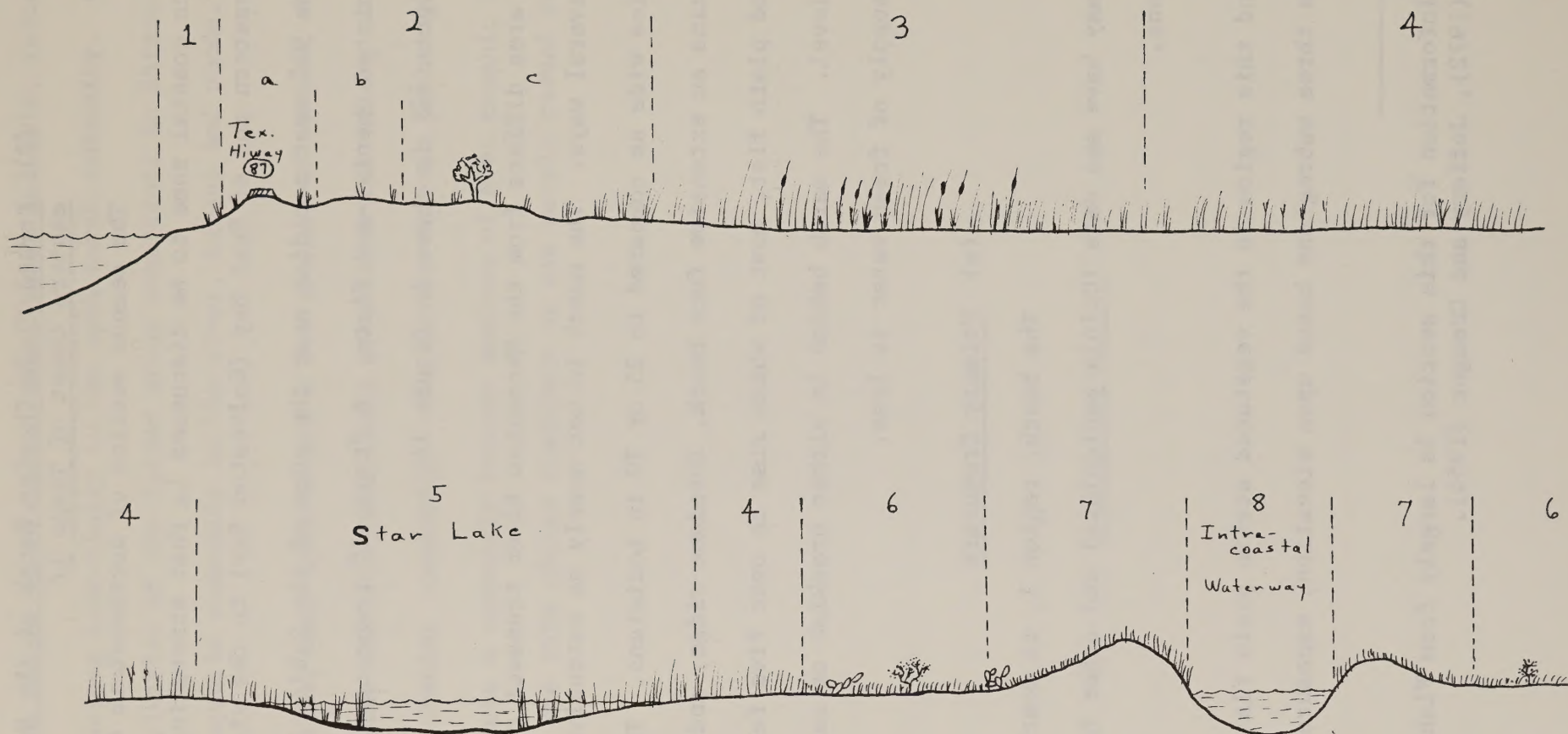


Figure 14.--Transect (b) of Figure 12: Cross-section of Strand Plain Chenier Marsh of the Northeastern Coast of Texas.

and spray, availability of subsurface moisture, and perhaps other factors. Region 2a is the foredune ridge, topped by Texas Highway 87 in this locale. Region 2b is the beach ridge and region 2c is the vegetated flat. All of region 2 is sparsely vegetated, the least growing in 2a and the most in 2c. Plants growing here include the halophytic grasses bluestem (Andropogon littoralis) and sea oats, gulf-dune paspalum (Paspalum monostachyum), coastal sandbur (Cenchrus incertus), milkpea (Galactia sp.), groundsel (Senecio spp.) and sumpweed (Iva ciliata var annua). Infrequently, mesquite (Prosopis spp.) and live oak can be found.

Region 3 is a brackish to fresh water marsh, the salinity varying with amount of precipitation, amount of time since last high storm tide, and location within this region. Vegetation here includes the glasswort (Salicornia bigelovii), coastal sacahuista (Spartina spartinae), marsh bay cordgrass (Spartina patens), big cordgrass (Spartina cynosuroides) bullrushes (Scirpus spp.), cattail (Typha latifolia) and rushes (Juncus spp.). In submerged areas the benthic, epiphytic, and planktonic algae occur in the same way as previously described for the Mermentau River transect in Louisiana coastal marsh.

Region 4, the closed brackish water marsh, is very slightly lower in elevation than region 3 and has a chain of small brackish ponds,

many of which are connected by bayous. The transect under discussion crosses one such pond, Star Lake, which is connected to others by Salt Bayou. This region, like number 3, receives water from flooding storm tides, precipitation and runoff. Being slightly lower, it is the catch basin for this water and is hence, a slightly saltier, closed system. Vegetation within consists of marsh hay cordgrass, big cordgrass, salt grass (Distichlis spicata), and rushes. The region being perennially wet, also has a population of epiphytic, benthic, and planktonic algae. Star Lake itself (Region 5) is very shallow and has marsh vegetation encroaching along its edges. The usual algal populations occur in the pond also.

Just beyond Star Lake is the beginning of the coastal prairie grasslands (Region 6). Dominant members of the vegetational association here are bluestem and indian grass (Sorghastrum spp.). Subordinate members are paspalum, mesquite, johnson grass (Sorghum halepense), hackberry (Celtis spp.), huisache (Acacia farnesiana), and cactus.

Region 7 and 8 are the Intracoastal Waterway and its dredge-spoil banks. The banks are vegetated largely by prairie grasses and the waterway is largely barren.

b. Consumers

The beach and strand plain flat, (Regions 1 and 2) constituting the sea rim, is much more extensive than that in western Louisiana, and can probably be considered a minor community, rather than an assemblage of a few resident plants and animals plus occasional or casual visitors. Faunal members of the seaward portions of this community are clams (Donax), snails (Terebra, Oliva, Polinices spp.), the ghost and sand crabs (Octopode sp. and Emerita sp.) and shorebirds, and other animals, mostly casual visitors. Primary production from dunes is not enough to sustain the animals living here and a considerable amount of nutrient materials is imported from the sea. Also, scant moisture in these regions would preclude the effectiveness of the detrital food chain shunt. The vegetated flat supports populations of rodents and probably rabbits as herbivores, with predators being mostly snakes, hawks, and owls. Herbivorous grazers of region 3, the brackish to fresh water marsh are mostly nutria, muskrat, and the swamp rabbit (Sylvilagus aquaticus), and numerous species of waterfowl. Predators are again snakes, predaceous diving birds, hawks, owls, and rarely mink. Alligators, largely omnivorous, occur in some parts of the marsh and in east Texas lakes and streams. Another omnivore here is the gulf spotted skunk (Spilogale indianola).

The closed brackish marsh, region 4, apparently has nearly the same fauna as region 3, based upon the limited amount of information available at the time of this writing.

Region 6, the prairie grassland, has major herbivore populations of rodents, rabbits, quail and prairie chicken that are preyed upon by snakes, coyotes, hawks and owls.

No information could be found about fauna of the Intracoastal Waterway and its dredge spoil banks.

All of the regions mentioned above must certainly have a wider variety of animals and plants than is presented here, but information for the segment of Texas coastline from High Island to Sabine Pass is very scant. No information whatsoever could be found for open water areas in the brackish marsh, such as Star Lake in the transect, but certainly, they must contain a complete aquatic system with import and export from and to the surrounding marsh and upland. It can be assumed however, that these ponds and bayous are of minor importance as habitat for species of animals spending part of their lives at sea and part in estuarine areas, such as the white and brown shrimp, because communication with the sea is indirect and tortuous, through Salt Bayou, several ponds, and Sabine Pass.

(3) Trinity River Bay-head Deltaic Marsh and Swamp

This section of coastline is somewhat remote from the proposed sale area, but is an integral part of the bay system and will be given brief attention here. Most of the information given here, along with the simplified transect (transect c of Figure 12 and Figure 15) is from Fisher et. al. (1972).

Region 1 is Trinity Bay and will be discussed elsewhere except to mention here that its edge marks the beginning of a salt-water marsh, and that it receives considerable nutrient import from marsh and swamp and stream above.

a. Primary Producers

Region 2 is the salt-water marsh which corresponds roughly to an area from 6 inches below mean bay water level to just above high tide level. Vegetation here is cordgrass, glasswort, seepweed (Suaeda spp), maritime saltwort (Batis mari-
tima) sea oxeye (Borrichia frutescens).

According to Renfro (1959), the salt cordgrass is the only species growing partly submerged in bay waters, probably because of the general turbidity of the water and the unsuitable bottom sediments.

Region 3 is a brackish water marsh. Near its upper limit, it grades into a fresh-water marsh, but near its lower limits, it

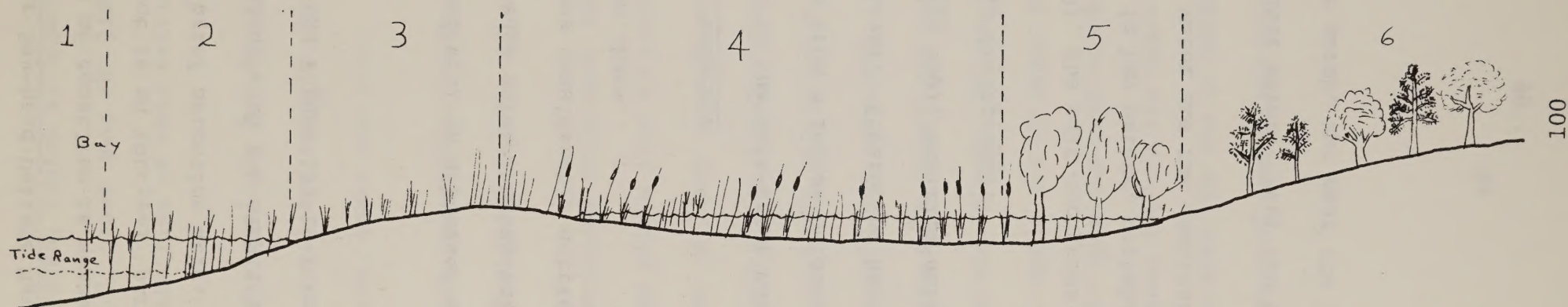


Figure 15.--Transect (c) of Figure 12: Cross-section of Trinity River Bay-head Deltaic Marsh and Swamp.

approaches a closed brackish water marsh. Thus, vegetation gradually changes from the more salt-tolerant spartinas of the salt marsh through the euryhaline spartinas and saltgrass and rushes to the more oligohaline coastal sacahuista, spartinas, cattails, bullrush and rushes.

Region 4 is an inland fresh-water marsh and receives bay salt water only rarely during high hurricane tides. Most of the water is supplied by precipitation and river run-off. Dominant plants here are rushes, bullrush, cattails, and sloughgrass (Spartina pectinata). Toward the upper end, where the wetland is more poorly drained, a swamp has developed (Region 5). The swamp association includes cypress (Taxodium distichum), Elm (Ulmus spp.), water oak (Quercus nigra), gum (Nyssa biflora), dwarf palmetto, mulberry (Morus spp.), grape (Vitis spp.), and yaupon (Ilex vomitoria).

Above the swamp is a mixed pine and hardwood forest (Region 6).

(b) Consumers

Salt water marsh consumers are waterfowl and probably marine snails, small crabs, grass shrimp and large populations of larval marine fishes and crustaceans. Besides eating the marine grasses, the waterfowl most likely graze the populations of small molluscs and crustaceans. Other grazing and predation

only results from visits to this region by non-members of the salt marsh community.

The brackish and fresh water marsh offers a larger variety of food, heavier cover, and more high ground (levees on the Trinity River) than the salt water marsh and hence has a larger variety and standing stock of fauna members. In wetter areas there are aquatic animals feeding on both living vegetation and detrital material; nutria, muskrat, and waterfowl may also feed, in part, on living vegetation. Secondary, tertiary, etc. consumers can include more omnivorous waterfowl, muskrat in part, rarely mink, snakes (especially cottonmouth), predaceous diving birds, and hawks and owls. In the swamp, in addition to these animals, but excluding most waterfowl, there are also raccoons, squirrels, and perching birds.

The faunal components of the mixed pine-hardwood forest community includes insects, spiders, and their relatives, assorted reptiles, quail, hawks, assorted perching birds, rodents, rabbits and coyotes.

4. Galveston Island - A Barrier Island

Transect No. 4 of figure 12, as shown in figure 16, is typical of barrier islands and peninsulas along the central and eastern Texas coasts. Compared to the three areas discussed above, the productivity is much lower in this transect. Three

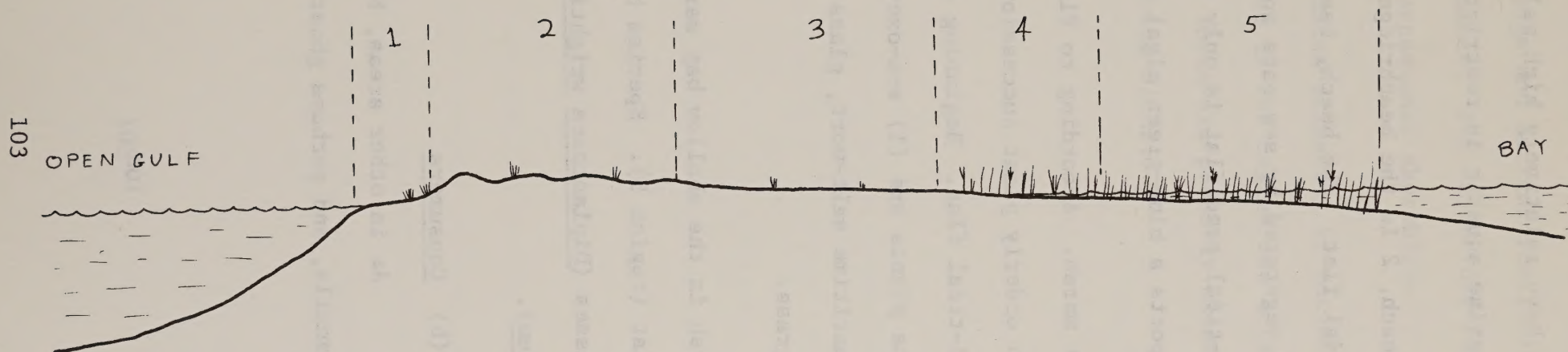


Figure 16.--Transect (d) of Figure 12: Cross-section of Galveston Island--A Barrier Island.

of the five regions to be described are almost barren, and the remaining two have relatively high salinities, so that life other than marine aquatic is restricted.

Region 1 is the beach, 2 is the beachridge and barrier flat, and 3, the wind-tidal flat. The beach, beachridge, and barrier flat are sparsely vegetated by sea oats and a few other halophytes. The wind-tidal sand flat is only a few inches above sea level and supports a blue-green algal mat.

Region 4 is a salt marsh. According to Fisher (1971) these marshes display an orderly plant succession from the bay line to the higher wind-tidal flat. Beginning at the edge of the wind-tidal flat the plants are (1) sea-oxeye, seepweed, Monathocloe, (2) maritime salt-wort, glass wort, salt grass, and (3) salt cordgrass.

Below the salt marsh in the shallow bay margin is a densely vegetated grass flat (region 5). Species here can include several marine grasses (Diplanthera wrightii, Ruppia maritima, Thalassia testudinum).

(b) Consumers

As in other areas, beach infauna includes several clams and snails, and perhaps ghost crabs, along with shore-

birds of various kinds. The shorebirds and ghost crabs also inhabit the drier beachridge and barrier flat, along with occasional rodents and snakes. The wind-tidal flat may have a few fiddler crabs and occasional shorebirds.

The grass flats are populated primarily by marine aquatic species, especially molluscs. Also in the region are a few visiting shorebirds and several fish. There are probably extensive visits by heron-like predaceous diving birds.

(5) The Galveston-Trinity Bay-Estuary-Lagoon System

Fisher et. al. (1972) describe this system as a relatively low-energy (waves) environment protected on the seaward side by well-developed barrier islands and peninsulas. Water exchange between the bays and Gulf is normally limited to tidal passes through the barrier islands. During storms Gulf waters also enter the bay through washovers and breaches cut through the barrier islands. Fresh water is supplied to the system by larger river systems terminating at the bay-heads, and by several small streams draining local areas of adjacent coastal uplands. Bathymetry and average surface salinity are shown in figure 17.

The bay margin consists of local beaches, relict berms and bay margin deposits, and small alluvial fans and fan deltas. According to Fisher et. al. there are about 50 square miles composing a band of shoal water at the bay margin, generally less than 2 to 3 feet in depth and commonly only a few inches deep. These shoal waters support fairly extensive marine algal and grass beds. The Galveston Island grass flats are vegetated chiefly by Diplanthera, while dominant vegetation off the Trinity delta and Clear Creek, generally in waters of lower salinity, consist chiefly of Ruppia. Local areas of shoal sand flats along Galveston Island

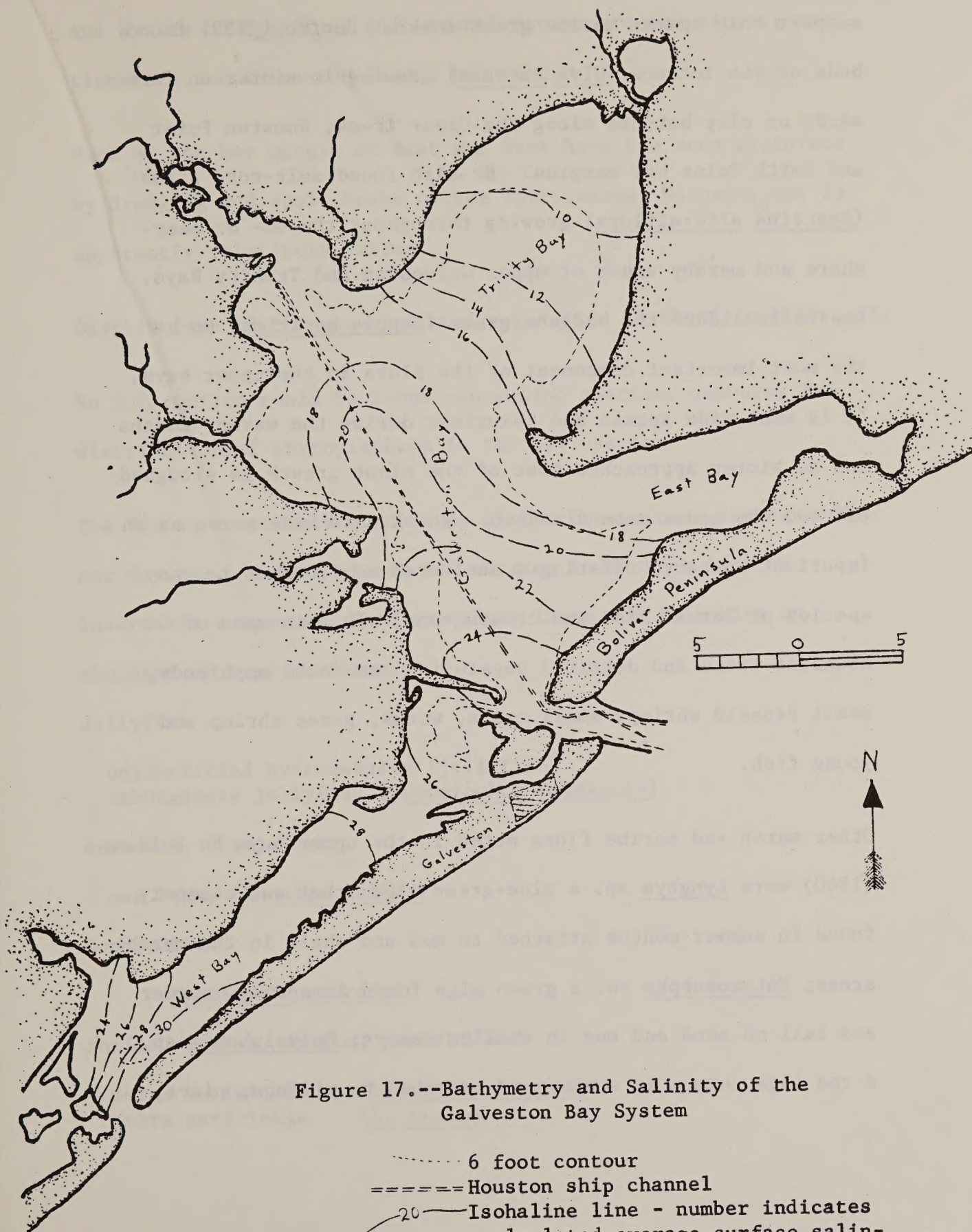


Figure 17.--Bathymetry and Salinity of the Galveston Bay System

- 6 foot contour
- ===== Houston ship channel
- 20 Isohaline line - number indicates calculated average surface salinity in ppt. (After Fisher et al., (1972).

support only sparse marine grass cover. Renfro (1959) found beds of sea lettuce (Ulva lactuca) growing in winter on firm sandy or clay bottoms along the Clear Creek, Houston Point and Smith Point bay margins. He also found salt-cord grass (Spartina alterniflora) growing throughout the on- or near-shore and marshy areas of upper Galveston and Trinity Bays. Renfro considers the widgeon grass (Ruppia maritima) to be the most important component of the flora in the upper bays. It is most wide spread and luxuriant during the warmer months and as winter approaches most of the plant growth is sloughed off and the grass mats diminish. The Ruppia beds serve as an important nursery, offering a sheltered environment to many species of larval fish and crustaceans. In this area of abundant fresh and detrital vegetation are found amphipods, small Penaeid shrimp, small crabs, worms, grass shrimp and young fish.

Other marsh and marine flora noted in the upper bays by Pullen (1960) were Lyngbya sp. a blue-green alga that was commonly found in summer months attached to mud and shell in the marsh areas; Enteromorpha sp. a green alga found in spring, summer and fall on sand and mud in shallow waters; Polysiphonia sp., a red alga common in summer and attached to pilings, piers,

and stalks of Spartina; and several marine grasses already mentioned in the Galveston Island transect.

Much of the bay margin of East and West Bays has been disturbed by dredging and spoil banks of the Intracoastal Waterway and is apparently relatively barren.

Distribution of the above marine vegetation is shown in Figure 18.

No information could be found concerning species, numbers, and distribution of phytoplankton in the bay system.

The faunal components of the bay system communities are extensive and diverse. Out of almost 200 entries in a check list of invertebrate species, Shidler (1960) lists the following as abundant or very abundant:

Jellyfish

unidentified hydromedusae (jellyfish)
cabbagehead jellyfish (Stomolophus meleagris)

Anemones, Corals, etc.

sea Pansy (Renilla mulleri)

Combjellies

Mnemiopsis macradyi

Snails, conchs, whelks, periwinkles:

marsh periwinkle (Littorina irrorata)
zebra periwinkle (L. ziczac)

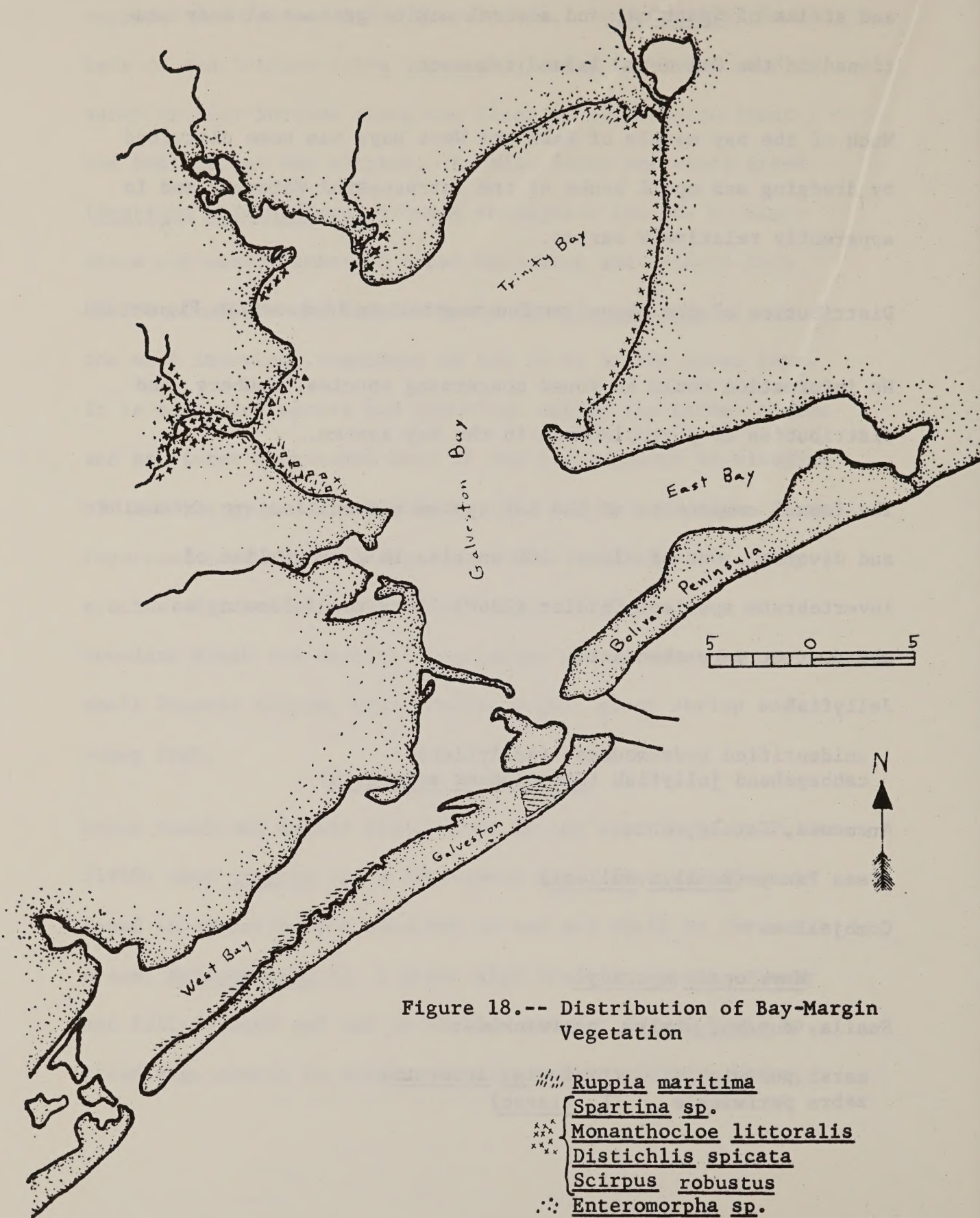


Figure 18.-- Distribution of Bay-Margin Vegetation

- /// *Ruppia maritima*
- xxx *Spartina sp.*
- xxx *Monanthocloe littoralis*
- xxx *Distichlis spicata*
- xxx *Scirpus robustus*
- xxx *Enteromorpha sp.*
- xxx *Lyngbya sp.*
- xxx *Ulva lactuca*
- xxx *Polysiphonia subtilissima*
- xxx *Diplanthera sp.*

Littoridina sphinctostoma

oyster conch (Thais haemostoma)

Limpets

false limpet (Siphonaria pectinata)

Mussels, oysters

hooked mussel (Brachidontes exustus)

commercial oyster (Crassostrea virginica)

Clams

mittchell's macoma (Macoma mittchelli)

coquina clam (Donas variabilis)

common short razor

clam (Tagelus plebius)

gulf jackknife clam (Ensis minor)

dwarf surf clam (Mulinia lateralis)

common mud clam (Rangia cuneata)

Barnacles

Balanus improvisus

Chthamalus fragilis

Isopods

sea roach (Lygida exotica)

Shrimp

white shrimp (Penaeus setiferus)

brown shrimp (P. aztecus)

grass shrimp (Palaeomonetes pugio)

Crabs

hermit crab (Clibinarius vittatus)

blue crab (Callinectes sapidus)

mud crab (Eurypanopeus depressus)

fiddler crab (Uca pugnax)

The high rate of biological productivity in this bay-estuary-lagoon system, and the extensive development of the detrital food chain is reflected in the very large and diverse bivalve populations. No information could be found on the zooplankton of the bay system.

Pullen (1960) compiled a check list of vertebrates from the Galveston bay system which included over ninety species of sharks, fresh water fish, marine fish, and a porpoise.

The list included representatives from all levels of the marine consumer food chain. There are omnivores such as the bull shark (Carcharhinus leucas) and sea catfish (Galeichthys felis), detritus and plankton feeders, such as the striped mullet (Mugil cephalus), menhaden (Brevoortia patronus), carp (Cyprinus carpio), and bay anchovy (Anchoa mitchilli) and a variety of predators including spanish mackerel (Scomberomorus maculatus), atlantic croaker (Micropogon undulatus), and white crappie (Pomoxis annularis). The single species of porpoise included on the list was Tursiops truncatus, the bottle-nosed porpoise.

Another type of community in the bay system is the oyster reef. Fisher et. al. (1972) describe them as follows: 1/

1/ Pg. 50 of Fisher et. al. (1972).

"A significant environment within Galveston, Trinity, and related bays is reefs built chiefly of the oyster (Cras-
sostrea virginica ... These form 23 square miles of reefs ranging in size from small clumps a few feet in width to complexes up to 5 miles in diameter. Reefs vary in plan from circular to elongate, with the smaller reefs tending to be circular and the larger reefs elongate. Where elongate in plan, the axis of the reef is commonly transverse to the dominant current direction. Oysters are sessile or attached organisms and dependent on circulating waters both for food and for removing waste materials. Favored bottoms for oyster-reef development are either fine, stable sands, or stiff, compact muds. Soft mud substrates or shifting sand bottoms are not conducive to reef growth and support. Another important factor in oyster reef growth and development is water salinity. Oysters exist in a wide range of water salinity from 5% to 30% (part per thousand)."

Hoffstetter (1959) noted at least 29 species of animals associated with the reef community, not including plankton. He listed the most abundant animals as barnacles, bryozoans, and mussels.

Periodically the oyster predator conch, Thais haemastoma, becomes moderately abundant. Mud crabs and blue crabs were also common. Annelid worms were also abundant in all reefs studied.

Approximate location of reefs is shown in figure 19.

There are several other bodies of water along the coast, in the area of coastal zone under discussion, such as East Matagorda Bay, Sabine Lake, Calcasieu Lake, Grand Lake and White Lake that are brackish and support communities of plants and animals similar to those in the Galveston Bay system, but they are so remote from possible impact caused by the proposed sale, that no discussion will be given for them. Also, no information of any kind could be found for the area between West Galveston Bay and East Matagorda Bay, which includes the Brazos River Delta at Freeport.

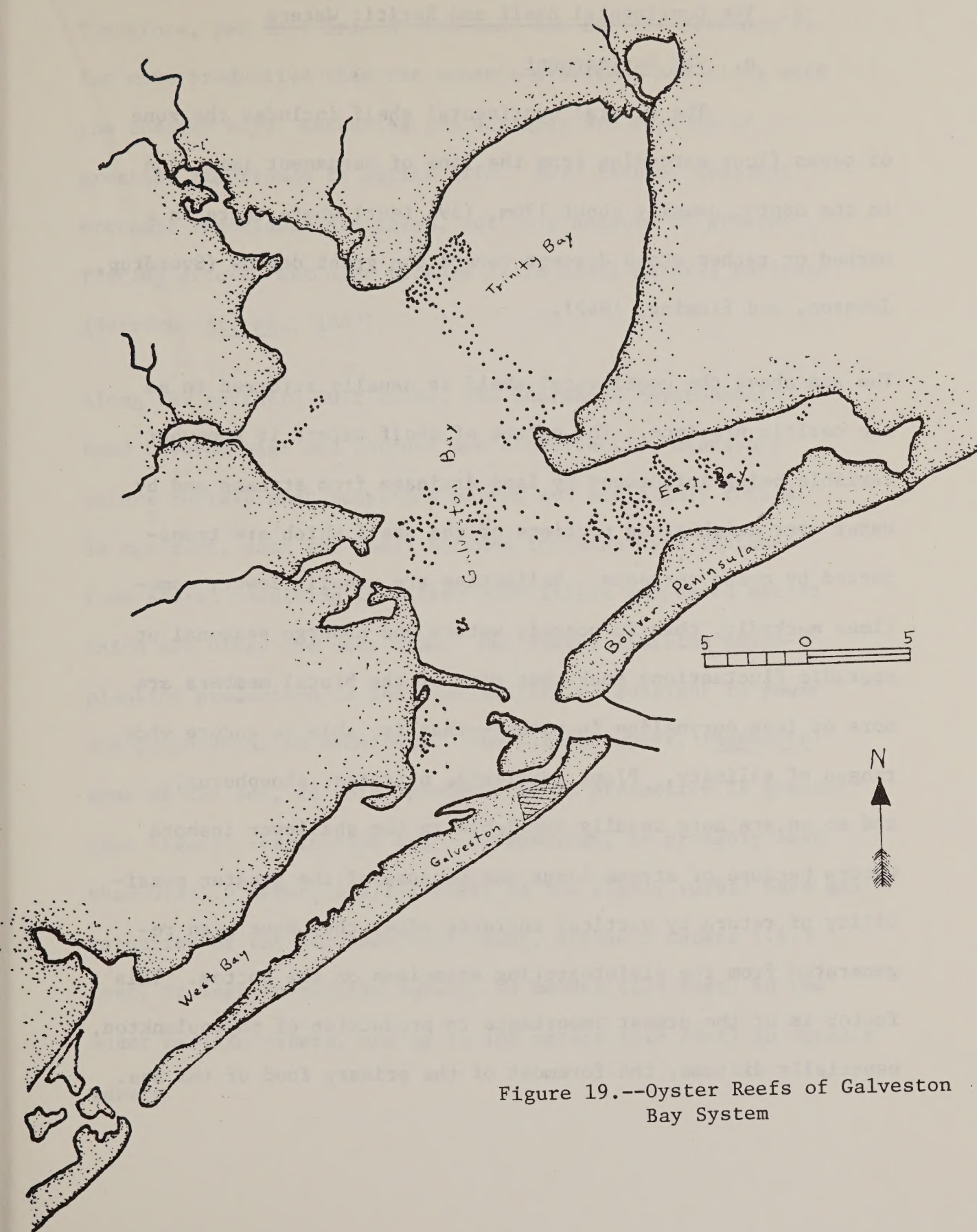


Figure 19.--Oyster Reefs of Galveston Bay System

2. The Continental Shelf and Neritic Waters

a. The Environment

The natural continental shelf includes the zone of ocean floor extending from the line of permanent immersion to the depth, usually about 120m, (394 feet) where there is a marked or rather steep descent toward the great depths (Sverdrup, Johnson, and Fleming, 1942).

The sea above the continental shelf is usually referred to as the neritic province. The nature of shelf waters is somewhat variable being influenced by land drainage from streams and by water over neighboring portions of the shelf which are transported by ocean currents. Salinities are usually lower, sometimes markedly, than in oceanic waters and undergo seasonal or sporadic fluctuations such that many of the biotal members are more or less euryhaline in nature--that is, able to endure wide ranges of salinity. Plant nutrients, nitrates, phosphorus, and so on are more readily available in the shallower inshore waters because of stream input and because of the greater possibility of return by vertical currents after they have been regenerated from the disintegrating organisms on the bottom. This factor is of the utmost importance to production of phytoplankton, especially diatoms, the foremost of the primary food of the sea.

Therefore, per unit area of the sea, the neritic province is far more productive than the oceanic province, and along with the coastal bays, estuaries and wetlands are regions of greatest importance to marine life. Here fish of greatest economic importance are taken, not only because of greater fishing effort, but also because it is their natural habitat. (Sverdrup et. al., 1942).

Along the northern Gulf coast, the nearshore environments tend towards high mud content and consequently, nearshore waters contain much suspended matter and are highly turbid. In contrast, sand and shell bottoms increase with distance from shore, resulting in waters with little suspended matter which are clear and deep blue. One factor limiting phytoplankton production is the availability of sunlight to power the photosynthetic machinery. The lighted upper, (euphotic) zone of the sea, in which photosynthetic production is greater than organic respiration and decomposition, is probably less than 0.5-1.0 meter (1 1/2-3 feet) in the highly turbid bays and estuaries of the northern Gulf coast, around 5 meters (16.5 feet) in inshore neritic waters, 25 meters (125 feet) in the outer neritic waters, and up to 100 meters (328 feet) in oceanic waters.

Organisms living in the shallow inshore waters are often exposed to extremes of environmental conditions. Extreme ranges of temperature and salinity have caused mass mortalities of fish and other animals off the Texas Coast. Nutrients are rarely limiting to phytoplankton growth and hence energy production in these waters. Towards the outer limits of the neritic province, where the waters are clear and deep, environmental conditions fluctuate within very narrow limits and change slowly, giving rise to more oceanic type biota. Nutrients are probably always limiting in these waters.

b. Communities

Major communities as defined by Odum (1959), are very hard to delineate in the ocean, and perhaps do not exist. However, Dice's (1952) community - the occurrence together of two or more related species- or Odum's minor community, is somewhat easier to identify. Also, in plankton communities or populations there is a seasonal cycle which precludes the establishment of a climax biota such as is known from land or the benthos. For the purpose of this discussion, the populations of the entire neritic province of the northwestern Gulf, and of the benthos, will be considered as communities.

(1) Producers

Dinoflagellates and especially diatoms are the source of nearly all primary production in the sea. Only locally do plants such as the seaweeds, bluegreen algae, or rooted grasses make a significant contribution to the energy economy in the marine system. In the northwestern Gulf, the coast is a broadly embayed deltaic coastal plain with extensive sandy beaches and marshes, and, no natural rocks. This, then, is the principal reason that macrophytic algae are very limited in abundance and restricted largely to jetties and piers. The genera of important neritic phytoplankton are somewhat ubiquitous in neritic waters of the worlds oceans, and the waters over the continental shelf of the northwestern Gulf contain the usual populations of Rhizosolenia, Biddulphia, Chaetoceros, Coscinodiscus, Skeletonema, Stephanopyxis, Lithodesmium, Ceratium, Gonyaulax, Noctiluca, and others.

Neritic phytoplankton undergo seasonal density cycles, as stated above. Generally, there are two major blooms per year, in spring and fall. Studies of these blooms, and phytoplankton populations in general, have led some ecologists to believe that population size is nutrient limited. Still others, finding a rapid increase

in zooplankton grazers after the onset of a bloom, with a subsequent drop in the phytoplankton numbers, have stated that grazing pressure is probably the limiting factor. In reality, a whole family of intermediate conditions exist.

(2) Consumers

(a) Grazers--the Zooplankton

The phytoplankton grazers include animals representing all major groups. Most important are the copepods, euphausiids, mysids, pteropod and heteropod molluscs, and the salps. Locally, protozoa and larval forms of many animals can be important. Zooplankton populations normally fluctuate in size according to the abundance of phytoplankton after a short lag in time. Some plankton called holoplankton spend their entire life cycle adrift in the oceans. Others, called meroplankton do so only while microscopic, larval stages of larger sessile or swimming forms.

(b) The Bottom Communities--The Benthos

Odum (1959) describes the benthos as large numbers of sessile or relatively inactive animals which exhibit marked zonation. He asserts that bottom organisms are generally distinct for each of the three neritic zones (supratidal, intertidal, and subtidal); benthic animals do not

necessarily change gradually from one species to another, but dominants often form more or less distinct bands or zones. These zones and associated fauna are shown in figure 20. Only dominant fauna are listed and include species described by Hildebrand (1954) as belonging to the bottom communities of the brown shrimp grounds in the western Gulf. Hildebrand includes mobile animals such as shrimp, flounders, croakers in his bottom communities. Inter and supra-tidal species are from Hedgepeth (1954) and Odum (1959).

(c) The Active Swimmers - The Nekton

Individuals of this group commonly, but not always, range over broad areas, and in so doing, participate in several biotic communities. Examples are the semicatatadromous fish such as the menhaden which are pelagic plankton larvae, estuarine juveniles, and pelagic adults. Other examples are the sharks which may cruise over broad areas of oceanic, neritic and bay waters searching for prey. Nevertheless, most nekton are limited in range by the same environmental conditions of temperature, salinity, available food materials, and type of bottom as are organisms which are less mobile.

The most important neritic nekton in the Gulf are the herring like fishes such as the menhaden (Clupeidae) and the anchovies

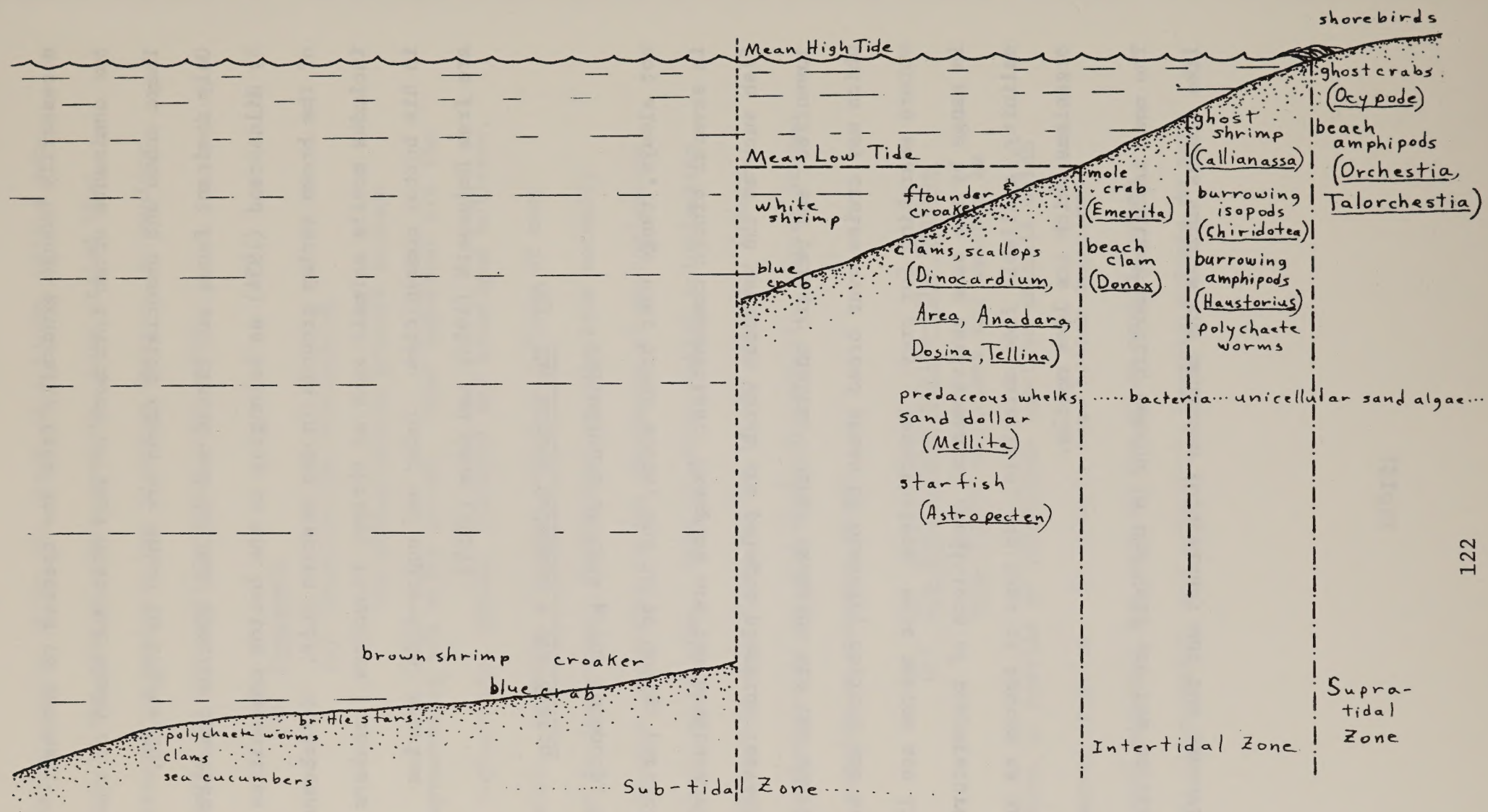


Figure 20.--Benthic Zones and Dominant Fauna
(after Hedgepeth-1954, and Odum-1959)

(Engraulidae). These make up the larger part of the secondary consumer link in the neritic food chain and are preyed upon by a great variety and number of other fish. Some other common or abundant nektonic animals, mostly fish, include the sharks (Carcharhinidae, Sphyrnidae), snappers (Lutjanidae), groupers and sea basses (Serranidae), spanish mackerel (Cybiidae), and squid (Loliginidae). Another larger group of animals, while nektonic and neritic, are closely connected to the benthic and near bottom communities for nearly all of their food supply. Near the surf zone or intertidal areas, over sand bottoms and grass beds live the sea robins (Triglidae), gobies (Gobiidae), midshipman (Batrachoididae), sea catfish (Ariidae), pipefish (Syngnathidae), and jacks and pompano (Stromateidae). Below this, roughly from a few feet below low tide level to about 20 fathoms, are large populations of spot, croakers, seatrout or weakfish (Sciaenidae), rays (Rajidae, Dasyatidae), hake (Gadidae), rabbit fish and puffer fish (Tetraodontidae), and shrimp (Penaeidae); even more numerous and varied are the populations of soles and flounders (Soleidae and Bothidae) including the commercial southern flounder, gulf flounder, little flounder, ocellated flounder, whiffs, fringed flounder, hog chokers, black-lined naked sole, and tongue sole.

The nekton populations associated with the bottom in deeper neritic waters seem to be only stragglers of those from shallower waters.

3. The Oceanic Region - The Deep Gulf

a. Environment

Most of the Gulf of Mexico lies beyond the edge of the continental shelf, covering a surface area of about 500,000 square miles and achieving a maximum depth of about 13,000 feet. The open Gulf is characterized by clear water, low biological productivity and little variation in environmental conditions. The lighted (euphotic or epipelagic) zone extends to a depth of about 150 feet and is relatively warm (approaching 90° F. at the surface in mid-summer). The bottom water is completely dark and exhibits temperatures only a few degrees above freezing. This stratification is reflected in the distribution of biological and chemical components of the deep Gulf. All but seventeen of the tracts proposed for leasing are very close to the deep Gulf, ranging from 4 to 55 miles from the 100 fathom depth contour.

The area just beyond the edge of the natural continental shelf, and underlying the edge of the proposed sale area contains a number of hills and domes that lie from 55 to 210 feet below the water surface. Some of these hills support extensive reefs of coral and carbonaceous algae which in turn are populated by

highly colored fishes and invertebrates of West Indian affinity. The most prominent of these reefs are situated on East and West Flower Garden Reefs located at $27^{\circ} 55' N$, $93^{\circ} 36' W$ and $27^{\circ} 52' N$, $93^{\circ} 50' W$ respectively.

b. Life in the Oceanic Region

The following brief account of the life and ecological zonation is taken from Bruun (1957). At the surface, light is the dominant factor in the epipelagic (euphotic) zone. The outstanding ecological feature here is that the animal consumers live in the same environment with the primary production by plants. Although the endemic species of the epipelagic zone migrate little or not at all, there are many animals which invade the epipelagic zone from deeper layers during the night or pass their early development stages in the photic zone. In either case, the abundant food supply is the primary factor.

Proceeding downward, a zone of dim light leads into the always dark mesopelagic zone, from which many species rise toward higher levels to feed during the night. Animals not undergoing nocturnal vertical migrations must depend on the "rain" of carcasses and detrital material from above for food. Still further downward, the discontinuity layer (where near surface temperatures

decrease with increasing depth) corresponds roughly to the bathypelagic zone. Temperatures here are below 50° F., and food gradually becomes scarcer. The bathypelagic merges with the abyssopelagic zone at the 39.2° F. (4° C.) isotherm, which is at about 1,800 meters (5,900 feet) in the Gulf of Mexico (Nowlin, 1972). Food, and hence living organisms are even more scarce here. Close to the bottom, an accumulation of organic debris from above starts a secondary production by heterotrophic organisms, serving as the first link of a new food chain in the benthic abyssal zone. Near the proposed sale area, the deepest waters are only as deep as the mesopelagic zone, due to the extremely wide continental slope.

A number of species in the oceanic, epipelagic zone are important to the sports and commercial fisheries. These include the mako shark (Isurus oxyrinchus), great white shark (Carcharodon carcharias), great barracuda (Sphyraena barracuda) wahoo (Acanthocybium solandri), the tuna and bonito (Scombridae), the sailfish and marlin (Istiophoridae), and a variety of reef fish.

E. Resources of the Northwestern Gulf of Mexico and Adjacent Coastal Zone

1. Land Use Patterns and Resources of the Coastal Zone

a. Land use patterns

Figures 21 a-c, indicate the locations of the major urban areas in the Texas and Louisiana coastal zone shoreward of the sale area. The East Texas coastal zone is one of the most heavily urbanized areas of Texas and is supported by a wide resource base. Petroleum production and petroleum-related industry are the primary activities which support these urban centers. Other activities which have contributed significantly to urban development in the region are agri-business, shipping, tourism, and commercial fishing. Because of this urban development, the waters of the Texas coastal zone are subject to the problem of pollution from residential and industrial wastes and the problem of multiple-uses by shipping, fishing, and petroleum industry interests.

The coastal area of western Louisiana has very little urban development, being predominantly marshland. There are, however, numerous small towns and the important fishing port of Cameron on Calcasieu Pass.

City	<u>Population (1970 U.S. Bur. of Census)</u>
Houston metropolitan area	1,985,031
Beaumont-Port Arthur metro. area	315,943
Galveston-Texas City metro. area	169,812

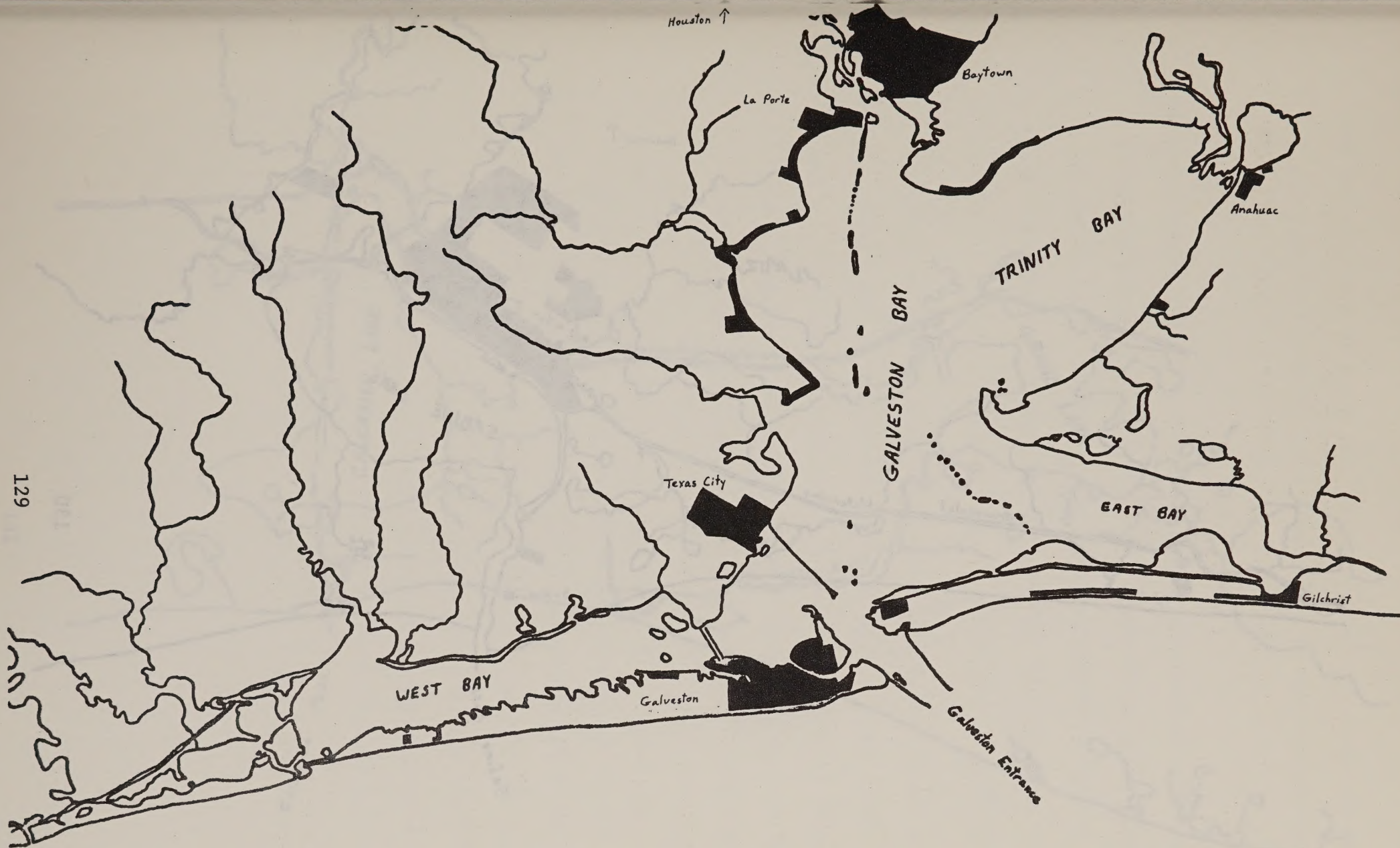


Figure 21,a.--Major Urban Areas of the Coastal Zone



Figure 21,b.--Major Urban Areas of the Coastal Zone

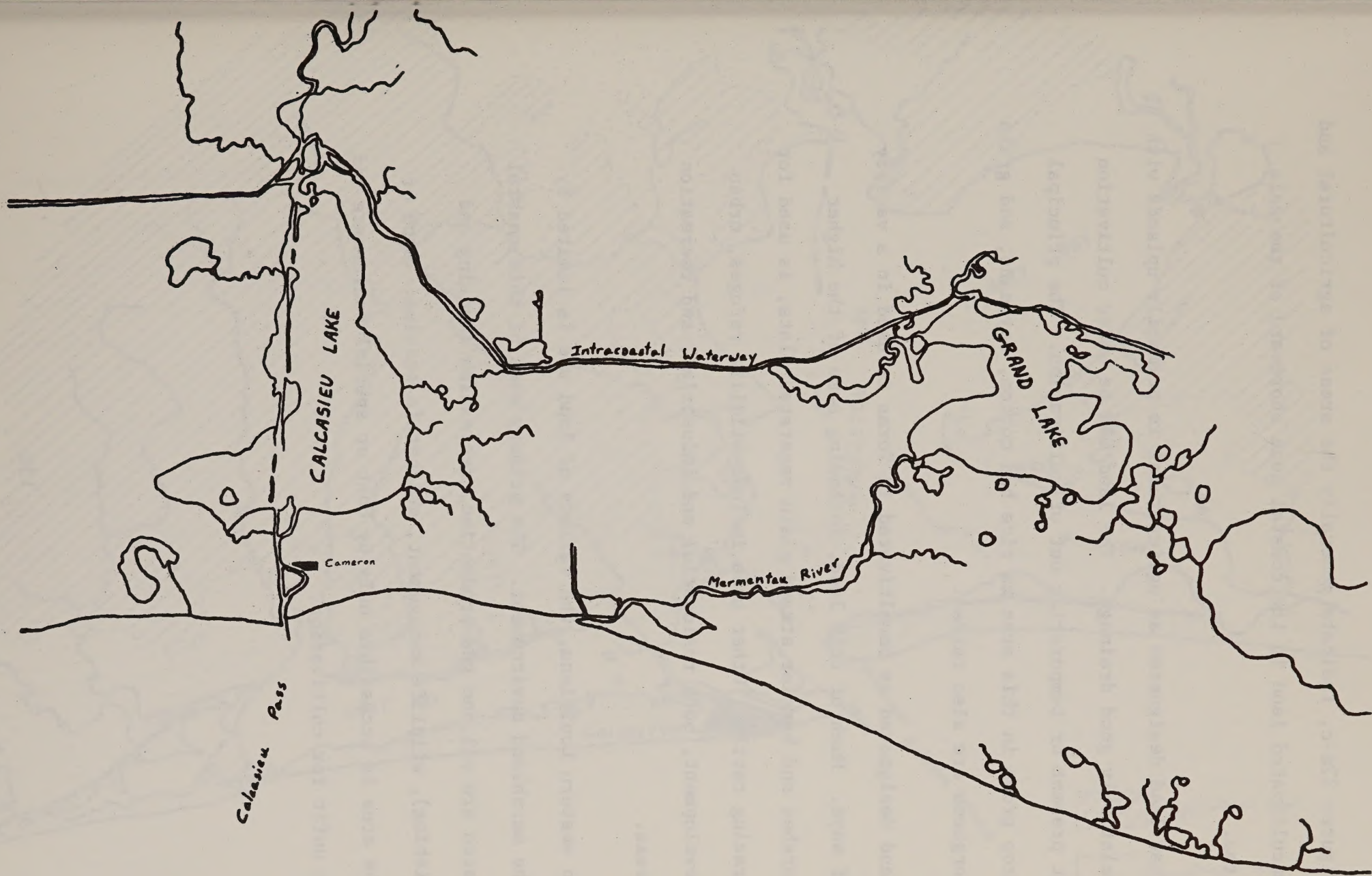


Figure 21,c.--Major Urban Areas of the Coastal Zone

Figures 22a-c, indicate generally the areas of agricultural and uncultivated land in the coastal zone shoreward of the sale area.

That land designated as agricultural is primarily uplands with relatively good drainage. The land may be under cultivation at present or temporarily out of cultivation. The principal crop grown in this area is rice but cotton, soybeans, and grain sorghums are also raised.

Land designated as uncultivated in Texas is used in a variety of ways. Much of this land, including some of the higher marshes and barrier strand plain vegetated flats, is used for grazing cattle. Other uses include wildlife refuges, urban development, both residential and industrial, and recreation areas.

In western Louisiana, the variety of land use is limited by the marshland environment. The primary uses of this coastal marsh are oil and gas production, recreation (hunting and fishing), wildlife management, and cattle grazing. Much of the area is accessible only by boat or special conveyance and is unfit for cultivation.



Figure 22,a.--Agricultural and Uncultivated Land of the Coastal Zone

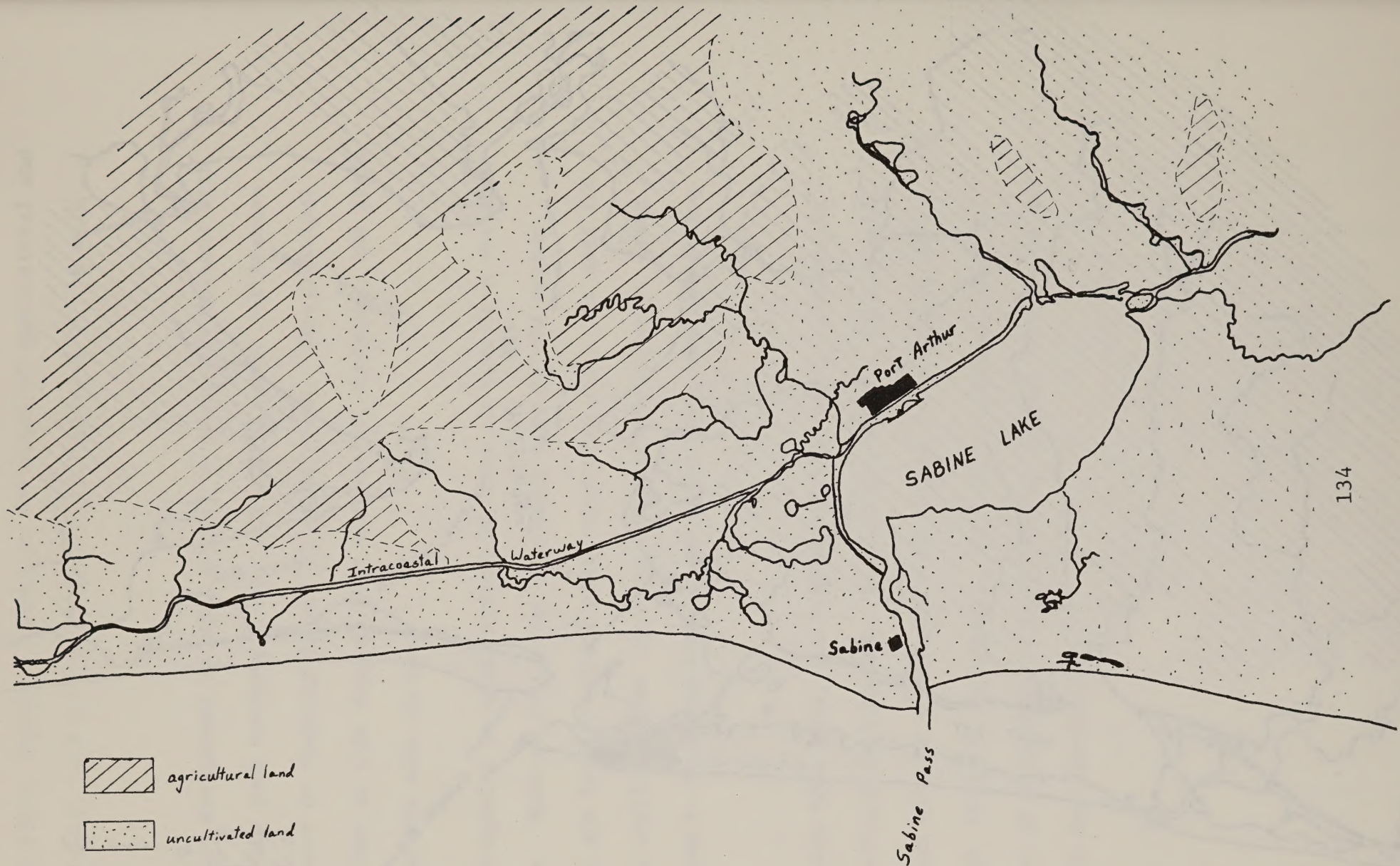


Figure 22,b.--Agricultural and Uncultivated Land of the Coastal Zone

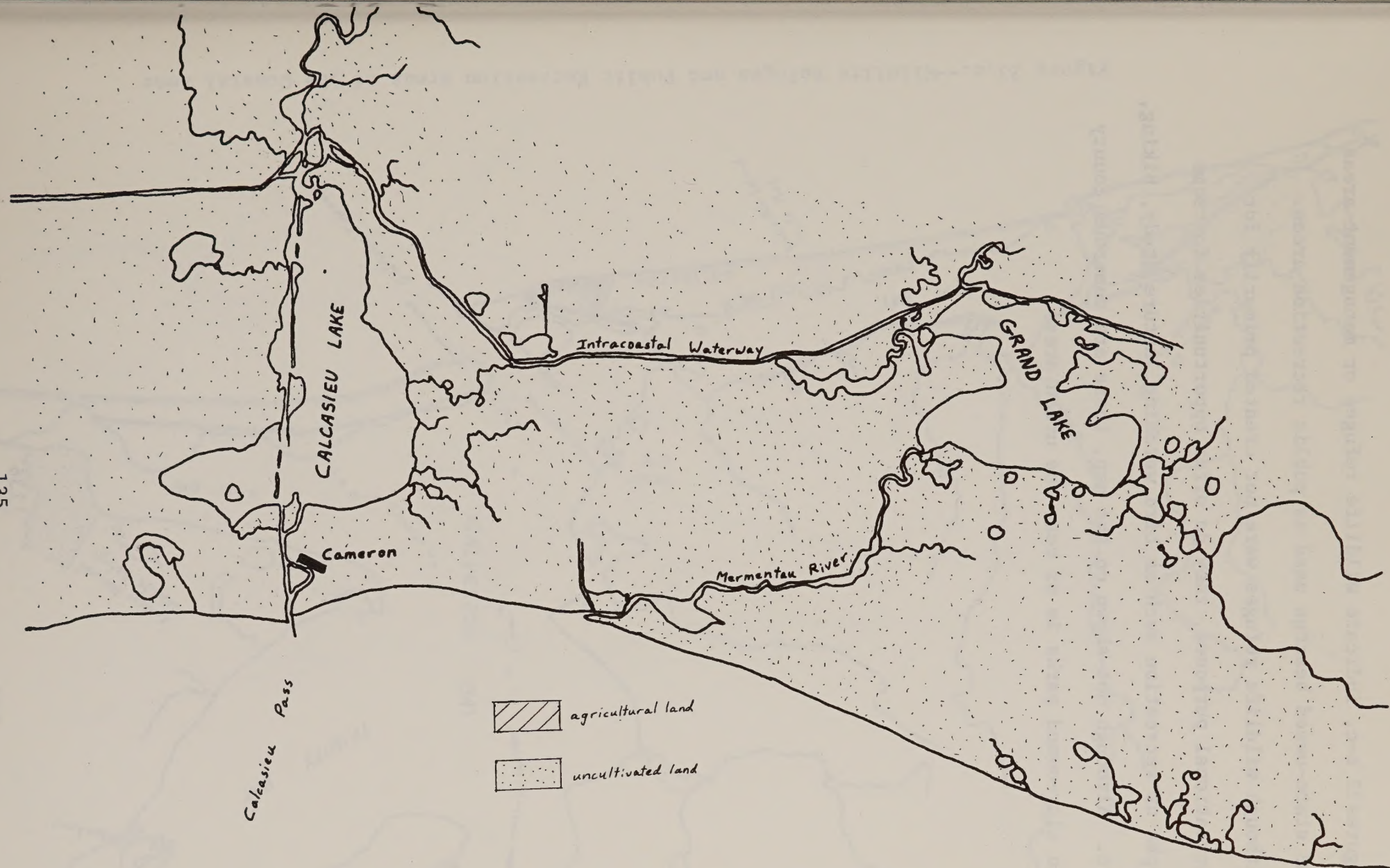


Figure 22,c.--Agricultural and Uncultivated Land of the Coastal Zone

Figures 23 a-c, indicate wildlife refuges or management areas and state-owned beaches used as public recreation areas. Although wildlife refuges were not created primarily for recreational purposes, they do offer opportunities for some types of recreation such as bird watching, nature study, hiking, etc. Although not shown on the map, there are numerous county and city-owned parks in or near the urban areas.

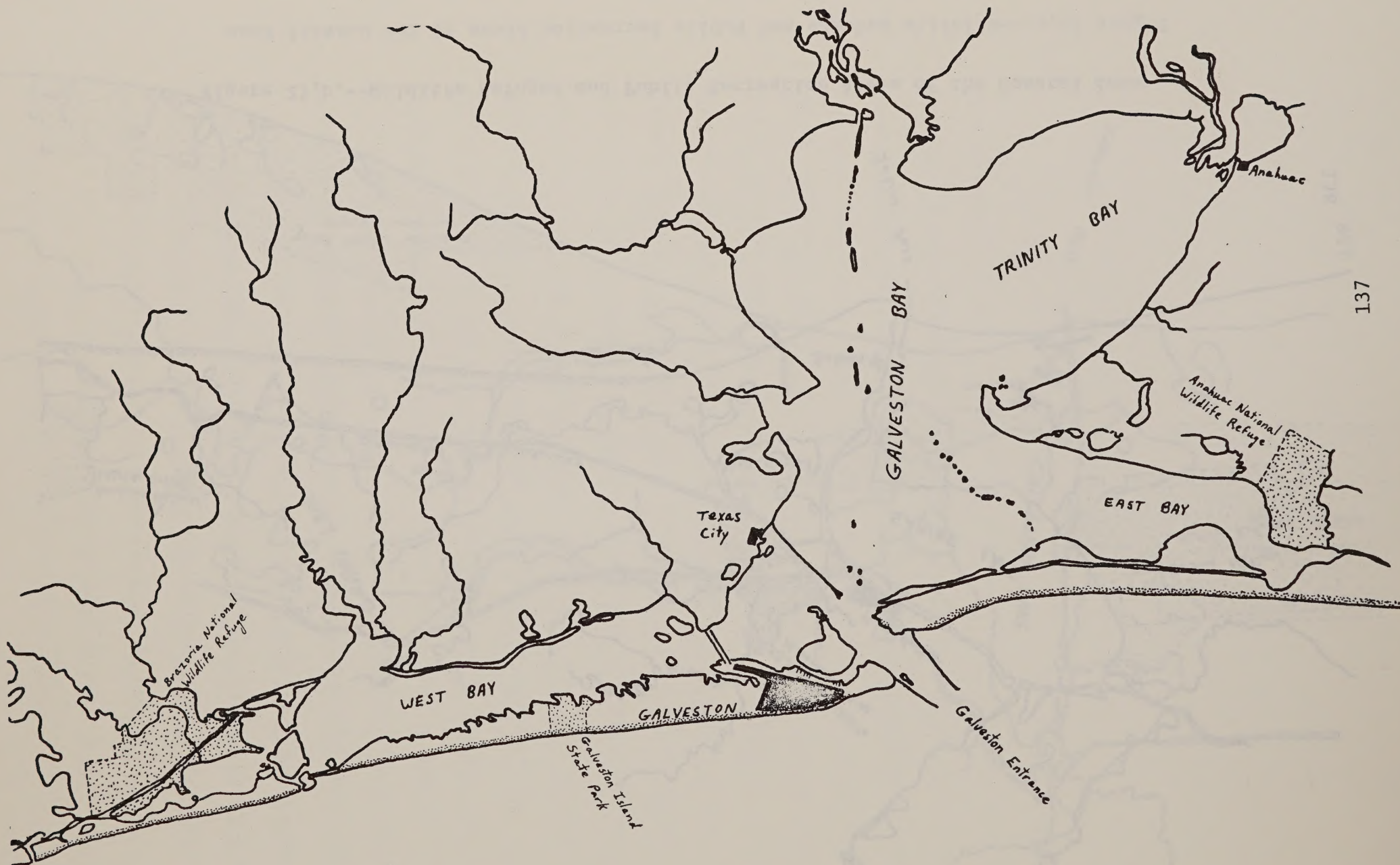


Figure 23,a.--Wildlife Refuges and Public Recreation Areas of the Coastal Zone

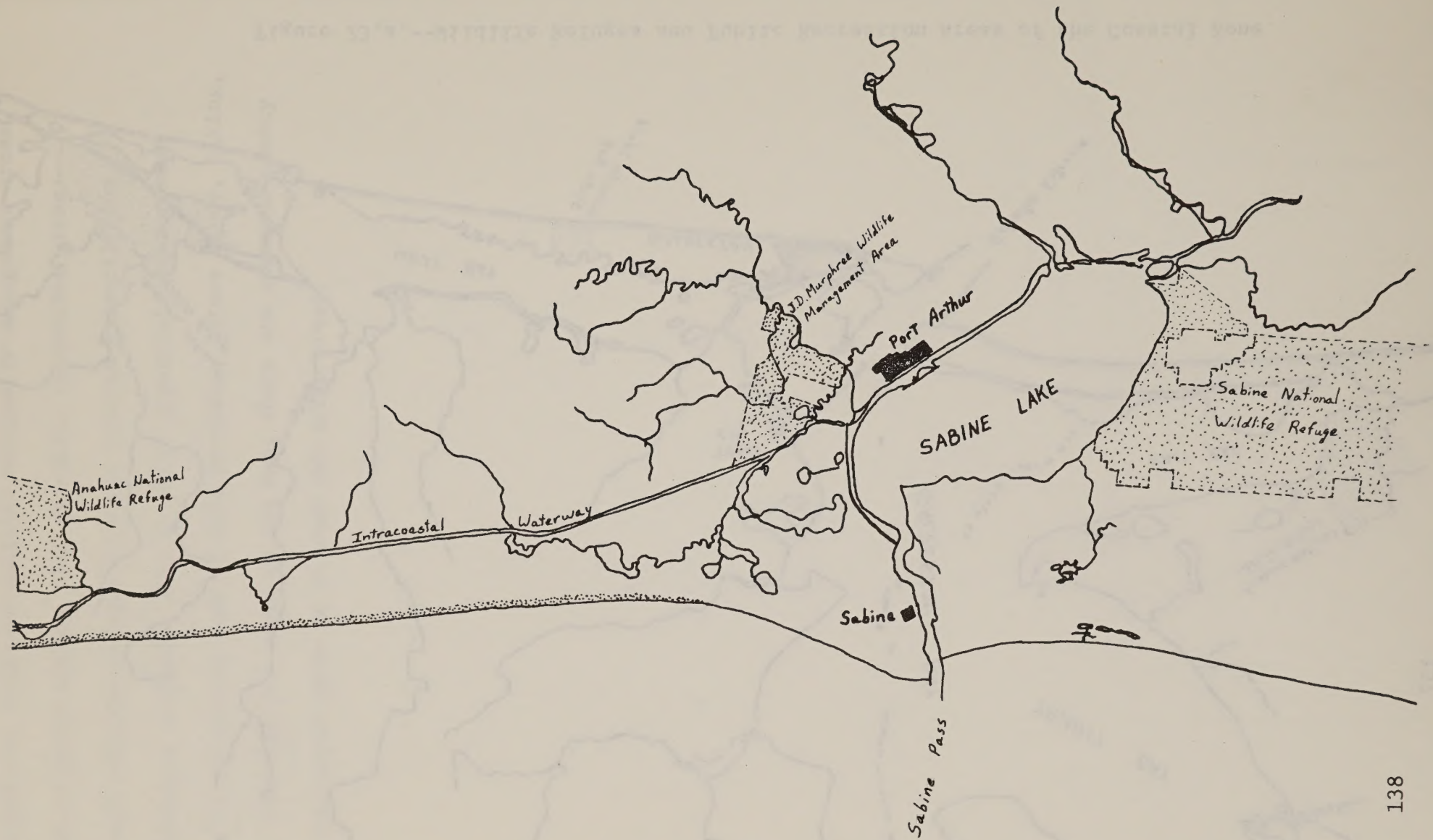


Figure 23,b.--Wildlife Refuges and Public Recreation Areas of the Coastal Zone

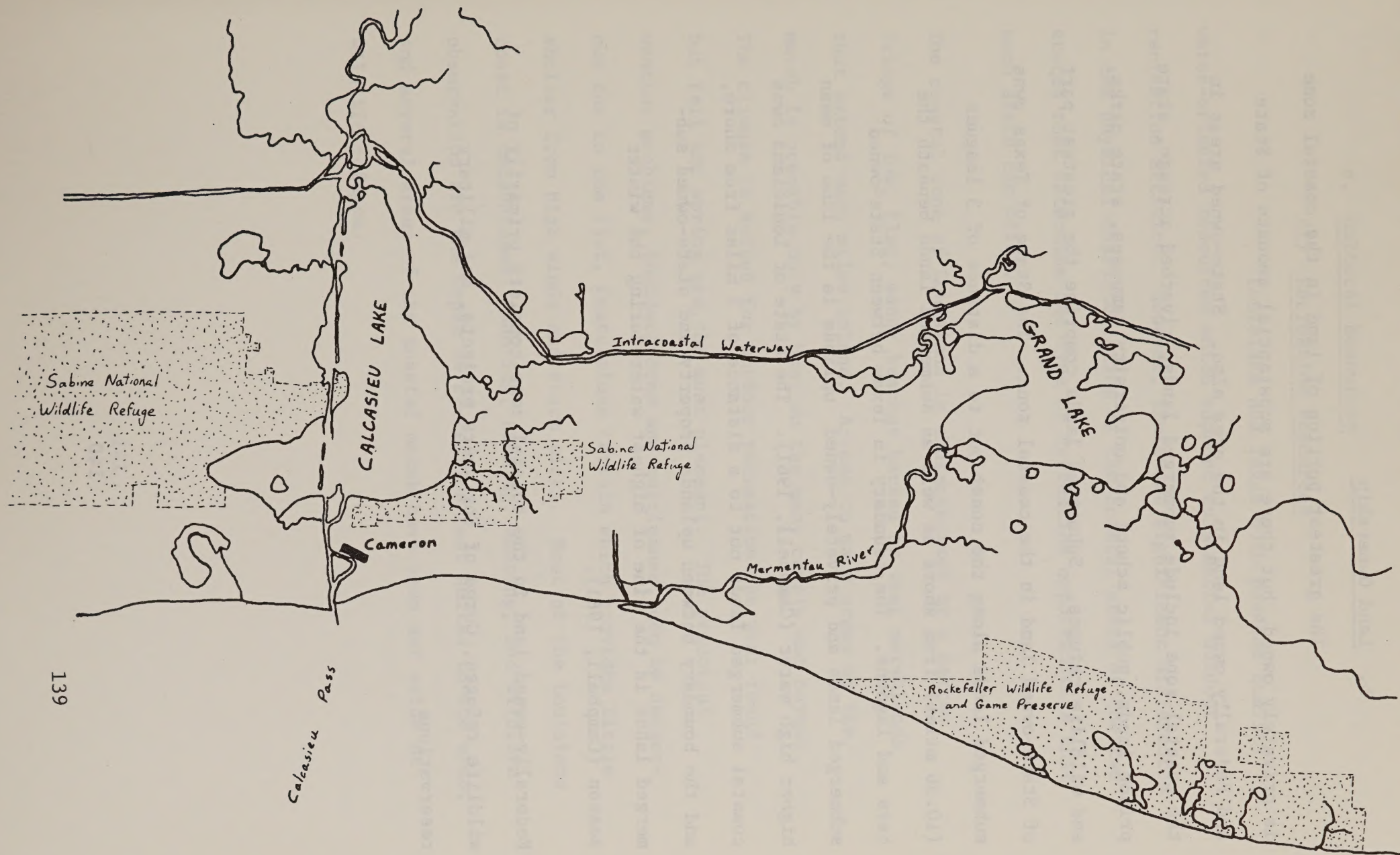


Figure 23,c.--Wildlife Refuges and Public Recreation Areas of the Coastal Zone

b. Land Ownership

The greatest portion of land in the coastal zone is privately owned, but there are substantial amounts of State and Federally owned land in the area also. State-owned areas in the coastal zone include submerged lands, riverbed acreage, state prison lands, public school and university campuses, state parks, and wildlife refuges. Submerged lands comprise the greatest part of State-owned land in the coastal zone. The State of Texas owns submerged lands along the coast out to a distance of 3 leagues (10.36 miles) from shore as well as submerged lands beneath the bays and lagoons. The boundary in Texas between State-owned submerged lands and privately-owned uplands is the line of mean higher high water (Campbell, 1961). The State of Louisiana owns coastal submerged lands out to a distance of 3 miles from shore, and the boundary between uplands property and state-owned submerged lands is the line of highest water during the winter season (Campbell, 1961).

Federally-owned land in the coastal zone consists primarily of wildlife refuges, Corps of Engineers projects, and military reservations.

c. Cultural Resources

(i) Recreation Resources

Louisiana and Texas both possess quality water-oriented resources which support substantial outdoor recreation activity. However, there are significant differences in the physical characteristics of the coastal areas of the two states that determine the type of recreation opportunities that each state can offer.

The coastal zone of Louisiana is characterized by a narrow fringe of low, flat, sandy beaches backed by vast marshlands that extend many miles inland. Access to many areas of the marsh is possible only by boat on the many canals and bayous. The climate is suited for outdoor recreation the year round but fall and spring are the most pleasant. The principal weather problems, thunderstorms and hurricanes, can be dangerous due to the flat, featureless terrain which provides little shelter from high winds and storm tides. Most of the Louisiana coast is undeveloped. Hunting, fishing, boating, and wildlife observation are the types of recreation best suited to the area, and several areas of the coastal marsh have been set aside as wildlife refuges.

The Texas coast is entirely a sandy barrier beach except for an area of marsh and mudflats immediately west of Sabine Pass. Much of the coastal barrier beach is backed by marsh and lagoons or bays. There are few areas which provide shelter for boats other than the bay entrances or interiors. The climate of the area is suitable all year for outdoor recreation. Most of the Gulf beach area is undeveloped except for areas near the larger coastal cities, but the bay shores are somewhat more developed, primarily for private purposes (Campbell, 1961).

The Texas coastal area is suited for recreational activities similar to those in Louisiana, (fishing, boating, wildlife observation) but is better suited for swimming than is the Louisiana coast. Air and water pollution problems near the large cities may detract from their attraction as outdoor recreation areas.

1. Federal Areas

The major Federal holdings in the coastal areas of East Texas and western Louisiana are the following wildlife refuges: Anahuac and Brazoria National Wildlife Refuge in Texas; and Sabine National Wildlife Refuge in

Louisiana. While the purpose of the refuges is to provide migratory waterfowl habitat, they also provide habitat for many other wildlife species as well as significant opportunities for recreation.

2. State Areas

State owned areas in coastal Texas and Louisiana which are available for recreation include wildlife management areas, historic monuments, state parks, and public beaches. The state owned wildlife refuges shoreward of the sale area include Rockefeller Wildlife Refuge and Game Preserve in Louisiana, and the J. D. Murphree State Wildlife Management Area in Texas. State parks include Galveston Island State Park (temporarily closed for development) and Velasco State Park which is the area between low and high tide on the Brazoria County, Texas shoreline. Federal, state, and private recreation and wildlife areas are summarized by acreage in Attachment D.

(ii) Historical and Archeological Resources

The National Register of Historic Places was consulted and it was found that there are no historical sites listed within the proposed lease sale area. Also, none of the sites chosen for submission to the National Register by the Texas State Board of Review (Briggs, 1971) are within the proposed sale area.

There are however, numerous historical and archeological sites along the Texas coast, shoreward of the sale area. Archeological sites contained in the Texas coastal lowlands and littoral area represent all known stages of aboriginal cultural development, and there are numerous historic sites, such as towns, forts, houses, missions and ship wrecks.

According to a report prepared for the U.S. Army Corps of Engineers by the Texas Archeological Salvage Project, (U.S. Army, 1972) ten percent of the land area within one mile of the shoreline and less than one percent of the water-covered area within the 3-league line have been systematically searched for archeological and historical sites. Thoroughness of coverage ranged from 50-80%, and sites were found to occur in densities up to four per square mile. Between Sabine Lake and Corpus Christi Bay the most common type of site found is the shell midden. These range in size from

small deposits representing a few days occupation, to large mounds indicating periodic occupation over hundreds of years. Of 717 sites documented over the last four decades, at least one third have been destroyed by erosion.

Virtually all navigable coastal waters of Texas except some of the more shallow bays such as Aransas Bay may be expected to contain sunken vessels of some historical interest. These vessels were probably involved in travel along the Texas coast. Wrecks of vessels involved in longer range activities, such as Spanish vessels of the 16th century, may be found offshore, most likely within 1/2 mile of the shoreline. A list of pre-20th century ship wrecks on the Texas coast, compiled by the Office of the State Archeologist, Texas Historical Survey Committee, (Briggs, 1971) indicates that there are at least eleven such ship wrecks on the coast shoreward of the sale area.

It is possible that more sites of cultural significance remain to be discovered within and nearby the sale area. There is a lack of knowledge concerning the locations and kinds of historic and archeological sites especially on the Outer Continental Shelf. Surveys are needed, especially in areas of potential oil and gas leasing, to locate and evaluate these resources before an accurate assessment can be made of the impacts of OCS oil and gas operations on resources of this kind.

In an effort to obtain a more complete knowledge of resources of historic and archeological value in the area and to respond meaningfully to Executive Order 11593 (Protection and Enhancement of the Cultural Environment), the Bureau's New Orleans-based Environmental Assessment Team is undertaking to locate, describe, and inventory existing archeological and historic sites on the OCS and in onshore areas, and State waters that might be affected by OCS activities.

Until such thorough surveys can be made, a means is needed to provide for the protection of these resources. Therefore, in order to identify and protect resources of historical, archeological, and architectural significance, and to comply with Section 2(b) of Executive Order 11593, a stipulation has been developed by the Department for possible inclusion in leases issued as a result of this proposed sale. This stipulation is presented in section IV.D.1 of this statement.

d. Wildlife Resources

(i) Birds

The proposed sale area lies between two major migratory routes of birds: the Mississippi flyway to the east and the Central flyway to the west. Consequently, the greatest variety of birds is found during migration, in the spring and again in the fall.

In addition to the geographic location, this section of coastline offers a wide variety in bird habitat. The long expanses of mud flats and beaches are inhabited by shorebirds, the shallow bays and wetlands offer habitat for wading birds, and the savannah and prairie offer suitable habitat for a great number and variety of birds.

(a) Waterfowl

Nearly all waterfowl known to occur along the northwestern Gulf coast spend the warmer parts of the year nesting and feeding in the far north and migrate down the Central or Mississippi Flyway to the Gulf coast after the onset of shorter days and cold weather. These birds may become extremely numerous during the peak of migration.

Most geese spend the winter in the coastal lagoons and marshes, grubbing for submerged aquatic vegetation. The Canada geese and to some extent, the blue geese, have learned to utilize

grainfields for food and may also spend time inland on fresh water.

The surface feeding ducks (or dabbling ducks, including the mallards, pintails, black and wood duck, teals, gadwalls, shovelers) exhibit a wide variety of feeding and resting habits. Several have adapted to farm ponds and grain fields, but others remain completely dependent on the coastal salt marshes for the winter home, dwelling there and feeding on aquatic insects, mollusks, marine plants, and marsh grass.

Of the diving ducks, only redheads, coots, canvas backs, and scaups spend much time on inland waters and in grain fields. The rest (buffleheads, hooded mergansers, goldeneyes, oldsquaws, scoters, and eiders) pass the winter either in coastal lagoons, bays, tidal lakes, or as pelagic birds far out into the open Gulf.

(b) Shorebirds

This is a diverse and highly mobile family (Sprunt, 1967). They are able to exploit a variety of habitats in the coastal prairies, Gulf coast marshlands and estuaries, seaward beaches, and less frequently, inland waters.

All but a few are dependent however, on wetland situations for most of the year. Even species that perform spectacular over-water migrations, such as the golden plover, must have the marshes and mud flats of the western Gulf coast for their return flight in spring. Plovers, small to medium-sized shorebirds, spend summers in the Arctic and winters in South America, stopping over in spring in pastures and mud flats along the Gulf coast. Sandpipers include both shore and wading birds, but most are seen along the ocean shores where they feed on small invertebrates. Avocets, medium to large slender-legged waders and phalaropes, including upland, shore, and pelagic species, are also present in the Gulf area.

(c) Large Fish-Eating Birds

A 1969 census from the region between the Sabine River and Matagorda City exceeded 45,600 of these birds. 1/ In order of decreasing occurrence, these long-legged waders included the cattle egret, white-faced ibis, white ibis, snowy egret, roseate spoonbill, common egret, Louisiana Heron, lesser Blue Heron, black--crowned Night heron, white pelican, great Blue Heron, Olivaceous Cormorant, Reddish egret, green Heron, yellow-crowned Night Heron, anhinga, and Least Bittern.

1/ Hildebrand, H. and G. Blacklock, 1969. The 1969 cooperative census of fish-eating birds along the Texas coast from the Sabine River to the Rio Grande. Unpublished report.

Lacking entirely in this region is the rare and endangered brown pelican. The egrets and herons are long-legged wading birds that may remain in their Gulf coast habitat the year round, feeding on fish and other small marine life. Cattle egrets feed largely on insects. The spoonbill and ibis family tolerates a wide range of salinities and local habitats but usually is restricted to the shallow bays, estuaries, lagoons, and marshes, along the Gulf coast. The white-faced ibis may migrate inland for summer nesting. The white pelican is locally common in breeding colonies along the Gulf coast in winter, and fishes by wading in shallow waters, often in flocks, scooping up fish with its large bill. Cormorants and anhinga are fish eaters that dine from the surface and swim underwater. The Double-crested cormorant migrates northward in summer.

(d) Other Birds

Colonial birds, such as gulls and terns, use the offshore barrier islands extensively for nesting and feeding. Large populations of rails and gallinules nest in the marshes during the summer. Snipe are present in large numbers during the winter. Scattered pairs of bald eagle and osprey may be found nesting along the Louisiana-Texas coast.

(ii) Mammals

Noteworthy mammals living in the coastal zone and depending largely on the swamp and salt marsh communities for food include the armadillo, bobcat, deer, gray fox, mink, muskrat, nutria, opossum, river otter, eastern and swamp cotton-tails, raccoon, striped skunk, and red wolf.

The river otter and red wolf seem to be facing extinction from this region. Deer and rabbit are taken by hunters. Mink, muskrat, nutria, raccoon and opossum populations are utilized extensively by fur trappers.

(iii) Other Wildlife

Reptiles along the coast include the alligator, (included on the official list of rare and endangered species along with the whooping crane, brown pelican, peregrine falcon, and red wolf, all from within or near the coastal area of interest)^{1/}, diamondback rattlesnakes, and numerous other snakes and lizards.

(iv) Wildlife Refuges

In order to provide sanctuary for migratory birds and other fauna of the area, a number of wildlife

^{1/} At least in western coastal Louisiana, the alligator is doing quite well. The State of Louisiana was able to open a limited hunting season for alligator in Cameron Parish in 1972.

refuges, and management areas have been established. (Federal, State, and private recreation and wildlife areas are summarized by acreage in Attachment D). Because of its location in relation to the Central and Mississippi Flyways and the wide variety of habitat the area offers for birds, the refuge areas are managed primarily for migratory and wintering waterfowl.

2. Commercial Fisheries of the Northwestern Gulf of Mexico

a. Important Commercial Species and Their Generalized Biology

The National Marine Fisheries Service lists the following species of fish and shellfish in their statistical publications as contributing to the commercial catches in the western Louisiana, Sabine, and Galveston Districts (Table A). The value of each species catch is impossible to include here, based on the information made available to us. The total worth of the commercial catch to each state, which includes some freshwater species, and many salt water species and catches made and sold outside of the proposed sale area was, \$72,630,000 for Louisiana and \$70,037,000 for Texas (National Marine Fisheries Service, 1972).

From the catch weights in Table A, it can be seen that croakers, drums flounders, king whiting, menhaden, red snapper, seatrout, sheepshead, blue crabs, shrimp and oysters composed the bulk of the catch.

The distribution and life history of these fish and shellfish and others of the Texas/Louisiana coastal zone vary between species but general groupings, with some overlap, can be identified. On the basis of these characteristics, fishery species are classed as resident, semi-catadromous, or seasonal migrant. (These terms are defined in the following sections.)

Table A

Commercial Fisheries Landings for 1971 in Louisiana and Texas 1/

(+) increase (-) decline (*) no change

<u>Species</u>	<u>Louisiana</u>	<u>Texas</u>
	<u>Pounds</u>	<u>Pounds</u>
<u>Fish</u>		
Bluefish	35	
Cabio	3,577	14,350
Croaker	294,342 +	52,220 +
Drum, Black	505,680 +	1,130,370 -
Drum, Red (Redfish)	723,642 +	2,003,799 +
Flounders (Unclassified)	463,150 +	338,728 +
Groupers	2,924 -	134,623 *
Jewfish	2,403	----
King Whiting (kingfish)	431,051 *	80,157 *
Menhaden	1,229,493,000 +	----- -
Mullet	8,193 *	99,035 *
Pompano	19,244	3,200
Sawfish	200	----
Sea Catfish	65,193	46,536
Sea Trout, Spotted	1,122,042 }	1,480,568 }
Sea Trout, White	131,561 }+	2,221 }*
Sharks (Unclassified)	905	----
Sheepshead, Saltwater	239,124 +	132,006 +
Snapper, Red	161,683 -	1,047,730 *
Spanish Mackerel	39,645	----
Spot	18,375	----
Tripletail	7,575	----
Unclassified	1,760	62,924,534
<u>Shellfish</u>		
Crabs, Blue	10,945,109 *	5,828,650 +
Shrimp, (heads-on)	92,612,883 *	84,883,769 *
Oyster (Meats)	9,757,737 *	4,702,852 +
Squid	3,078	11,884

1/ Recent Status = Approximately 1950-71. Data used is from U.S. Dept. of Interior, 1967, 1968, 1969; U.S. Dept. of Commerce, 1971, 1972a, b.

1. Resident Species

Resident species complete their life cycle in estuaries and are dependent on this zone most of the time. Oysters, blue crabs and spotted seatrout are classed as resident species although blue crabs and spotted seatrouts may for a short time, venture into the shallow coastal waters. All three species contribute significantly to the commercial fishery, and spotted seatrout and blue crab are also sought by recreation fishermen.

Since the advent of offshore oil and gas activities, other resident species of the continental shelf have become concentrated around drilling structures. Among these are: red snapper, groupers, trigger fish, spade fish, giant sea bass, pompano, and many smaller species. Speculation that these species and other larger, seasonal game fish, such as sailfish and marlin, have appeared only since the offshore oil industry became active is erroneous. However, the platforms do create artificial environments which attract and concentrate many predatory species.

2. Semi-Catadromous

Semi-catadromous species spawn in the Gulf of Mexico, the young migrate to their estuarine nursery area, where they grow to sub-adults; then they return to the ocean where their life cycle is completed. Some species may return to the estuaries for short

periods as adults. Major species include white shrimp, brown shrimp, menhaden, Atlantic croaker, spot, black drum, red drum, sand seatrout, southern flounder, and saltwater sheepshead. As noted above, these species contribute significantly to the commercial fishery, and, except for menhaden, are also caught in great numbers by sport fishermen.

3. Seasonal Migrant Species

The seasonal migrants generally reside in the nearshore waters of the continental shelf during the summer season, and some may forage briefly in the estuaries. They appear in late spring as the waters warm and depart as the water temperature declines in the fall. They either winter in the warmer offshore waters of the Gulf of Mexico or migrate to warmer coastal waters off Mexico or southern Florida. Some spend considerable time in the vicinity of the oil and gas platforms. Major species are the spanish and king mackerel, tarpon, ladyfish and several species of jack, bluefish and cobia. Several of these, in other areas of the Gulf, are semi-catadromous. Other species found in the offshore waters include marlin, sailfish, wahoo, and a variety of tuna, sharks, skates and rays. At this time, none are important as major commercial species in Texas and Louisiana, but most are sought by recreation fishermen.

b. An Overview of the Fisheries

Thompson and Arnold (1971) give the following account of Gulf fisheries:

"Since the days of the aborigines the Gulf of Mexico has been a source of seafood for Americans. The abundance of fish and shellfish in innumerable bays, sounds, and lagoons along the coast provided pioneer settlers with their own needs and also were a basis for trade with inland colonists. By the mid-1850's, commercial fishing was fairly well established, but still was conducted almost entirely in inshore waters or within a few miles of the coast, except for the offshore red snapper fishery.

"According to the first statistical survey in 1880, the Gulf fisheries of the United States yielded 23.6 million pounds, valued at \$1.2 million. (By 1888, Gulf fisheries included oysters, red snappers, mullet, seatrout, red drum, sheepshead, shrimp, blue crab, sponges, and turtles.)

"The Gulf fisheries have been in a period of accelerated expansion since 1940. This is quite different from the fisheries in other regions, which are mainly static or declining. The marked increase in quantity and value of

Gulf fishery products during the last quarter of a century was primarily due to expansion in the shrimp and menhaden fisheries. Blue crab catches also increased substantially. A new fishery was started in 1952 to supply a variety of small trawl-caught bottom fishes--previously unutilized--for manufacture into pet food. Catches of other species, of which there are 50 to 60, were maintained with relatively minor deviations around their long-term average."

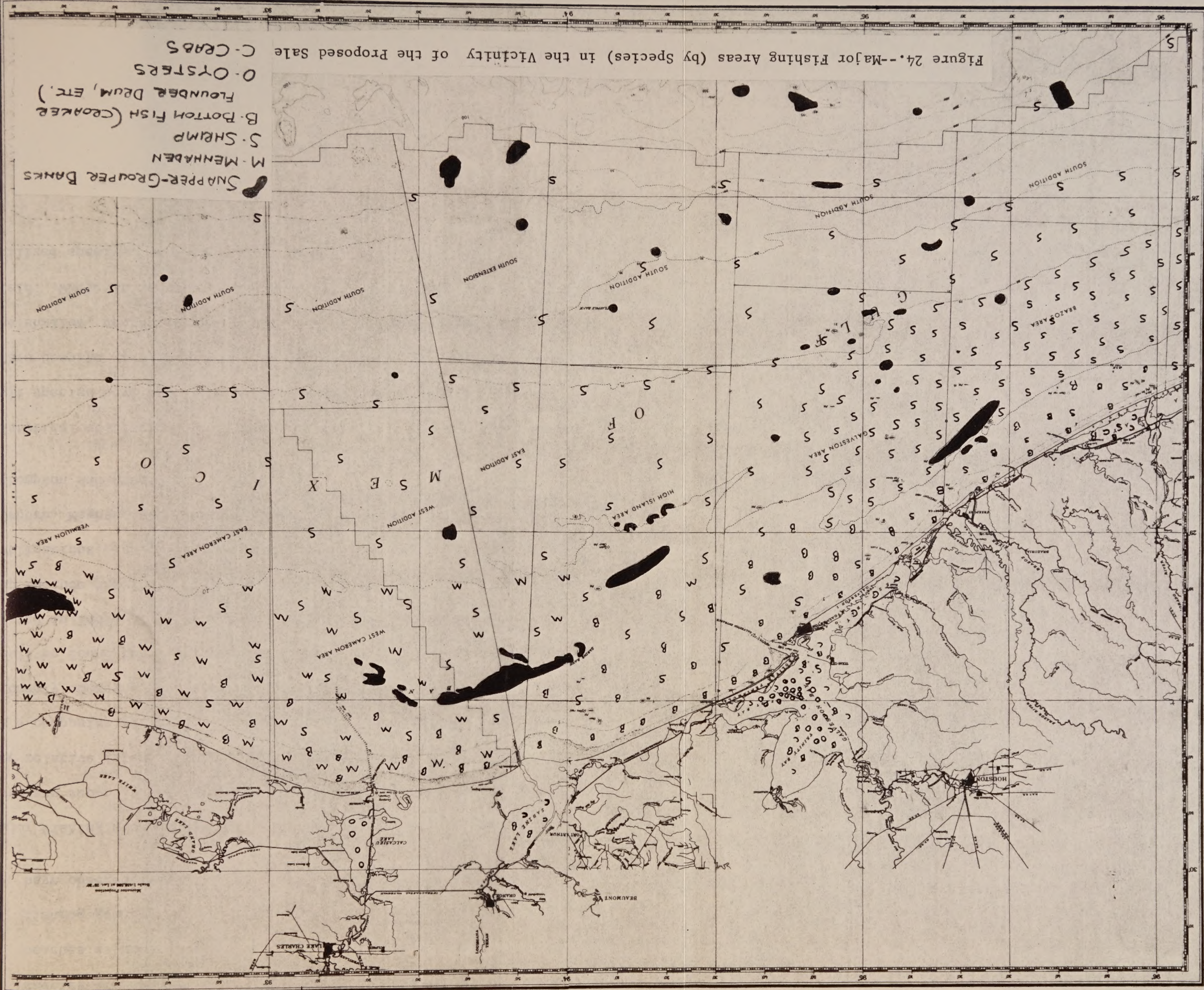
The shrimp fishery and industrial bottom fishery grew by expanding the fishing grounds. "The industrial fishery for the pelagic menhaden expanded production by intensifying its harvest of the resource on traditional grounds. These are in shallow coastal waters off Mississippi and Louisiana and one small area off western Florida. Menhaden fishing along most of Texas and all of Alabama normally is prohibited by State law...

The fishing grounds for other species of fish in the gulf have remained unchanged through the years. The snapper and grouper grounds are the same today as they were before the turn of the 20th century. Sea-trout, mullet, drum, and other estuarine-dependent

species are caught in bays, passes, and along the beaches as they always have been...Similarly, the fishing grounds for shellfish (other than shrimp) have changed little."

Major fishing grounds and banks in the vicinity of the proposed sale area are shown in figure 24. The spacing between symbols shows the relative intensity with which the species are fished. The map is a composite of smaller maps and verbal descriptions, and hence, probably contains gaps and inaccuracies. Also, no information could be found for fishing grounds for many of the commercial species listed in Table A. Sources of information used to construct the map include the Texas Offshore Fishing Chart (Tidewater Fishing Publications, Inc.; Seabrook, Texas); Gulf of Mexico Shrimp Atlas (Osborn, Maghan, and Drummond, 1969), and Gulf of Mexico Fisheries (Thompson and Arnold, 1971).

Historical statistical data show that total catches for many popular Gulf species have maintained reasonably constant levels in recent years despite growing fishing efforts indicating that fisheries in the shallow, nearshore waters may be approaching maximum sustained yield. While it is true that some of the less popular and under-utilized species, such as mullet, have a significant potential for



increased harvest in shallow waters, the catch has been held constant owing to a lack of markets. In the main, major new expansion of gulf fisheries will probably have to come from fishing farther offshore in increasingly deeper waters. Exploratory fishing by the Bureau of Commercial Fisheries (Wathne, 1959; Bullis and Thompson, 1970) has shown that commercial quantities of a number of desirable species can be caught along the outer edge of the continental shelf and over the deep gulf. Some of these species are:

<u>depth, fathoms</u>	<u>species</u>	<u>fishing method</u>
30-50	brown shrimp, porgy, atlantic croaker, butterflyfish	trawl
shelf beyond 50	hake, wenchman, rattails	trawl
100	yellowedge grouper	longline
150-200	tilefish	longline, trawl
200-350	royal red shrimp	trawl
330-350	swordfish	longline
100-1000+	yellowfin tuna	longline

3. Sport Fishery in the Western Gulf of Mexico

The 1965 Salt-Water Angling Survey (Deuel and Clark, 1968) contains the following information about sport fishing in the western Gulf (Gulf Coast from the Mississippi delta to the Mexico Border).

In 1965, an estimated 738,000 anglers caught 89,550,000 fish weighing 93,809 tons. The survey also reveals that about 2/3 of the anglers fished in the rivers and bays rather than offshore, although the pounds of fish caught was about equal for both categories. Twenty-five species were listed as having made up almost the entire sports catch. In decreasing order of poundage caught, they were: spotted seatrout, snapper, sand seatrout, black drum, red drum, croaker, king mackerel, white perch, grouper, summer flounder, kingfish, dogfish shark, bluefish, porgy, catfish, mullet, shark, spanish mackerel, pompano, jack, cobia, barracuda, grunt, dolphin, and atlantic spadefish, and miscellaneous other fishes.

The biology of many of these species is discussed in the preceeding section on commercial fishing.

4. Oil and Gas Resources

As of September 30, 1972, there were 5,774 wells with 9,457 completions capable of producing oil and gas in the OCS of the Gulf of Mexico. Of these, 111 wells with 159 completions are found in the OCS offshore Texas. Oil and gas production from the OCS leases offshore Texas during 1971 accounted for 1.7 million barrels of oil and 127 billion cubic feet of gas with a market value of \$26.3 million. Oil and gas production in 1971 from the OCS leases in the Gulf of Mexico accounted for approximately 387 million barrels of oil and 2.8 trillion cubic feet of gas with 1.5 billion gallons of gas liquids, with a total market value of \$201 billion. Since the inception of the OCS leasing program, the cumulative value of offshore production in the Gulf of Mexico through 1971 has been \$10.3 billion.

The hydrocarbon production of offshore Texas is predominantly gas, which has been developed along the Miocene trend and the original gas reserves amount to 1.6 trillion cubic feet from 17 fields. The original oil reserves of this Texas Miocene trend have been calculated to be 106 million barrels from eight fields.

BIBLIOGRAPHY

- Briggs, Alton K. 1971. Archeological Resources in the Texas Coastal Lowlands and Littoral. Texas Historical Survey Committee. Texas Water Quality Board. 42 p.
- Bullis, H. R. and J. R. Thompson. 1970. Bureau of Commercial Fisheries exploratory fishing and gear research base, Pascagoula, Mississippi. July 1, 1967 to June 30, 1969. Circ. 351. U.S. Department of Interior. Fish and Wildlife Serv. Washington, D. C. 29 p.
- Campbell, R. D., H. L. LeBlanc, M. A. Mason. 1961. Shoreline recreation resource study, an evaluation of the shoreline recreational resources of the United States, Outdoor Recreation Resources Review Commission, George Washington University, Washington, D. C.
- Cochrane, J. D. 1965. The Yucatan current and equatorial currents of the western Atlantic. In unpublished report of Dept. Oceanog. and Meteorol. Texas A & M Univ. Ref. No. 65-17T.
- Darnell, R. N. 1971. Oceanographic report for coastal zone study. p. 1-21. In J. T. Goodwin and J. C. Mosely (ed.) The coastal resources management program of Texas. Appendices to the Interim Reports. The Interagency Resources Council, Office of the Governor, Austin, Texas. p. 1-130.
- Deuel, D. G. and J. R. Clark. 1968. The 1965 salt-water angling survey. Bur. Sport Fish. and Wildl. Resource Pub. 67. U.S. Dept. Interior, Washington, D. C. 51p.
- Dice, L. R. 1952. Natural communities. Univ. Michigan Press. Ann Arbor. 547 p.
- Fischer, Bill, Flawn, Peter T. 1970. Land-use patterns in the Texas Coastal zone. Bureau of Economic Geology. Univ. of Texas at Austin. In Goodwin, James T, Moseley, Joe C (ed). The coastal resources management program of Texas. Appendices to the Interim Report. Vol I. The Interagency Natural Resources Council, Office of the Governor, Austin, Texas. 1971.
- Fisher, W. L., J. H. McGowen, L. F. Brown, and C. G. Groat. 1972. Environmental geologic atlas of the Texas coastal zone--Galveston-Houston area. Bur. Econ. Geol. Univ. Texas. Austin. 91p.

- Fleming, R. H. and C. C. Bates. 1952. The engineering application of sea and swell data. pp. 88-97. In Second conference of coastal engineering. (Original not seen).
- Gunn, Clare. 1971. The texas gulf coast as a tourism-recreation region. In Goodwin, James T., Mosely, Joe C. (ed.). The coastal resources management program of Texas, appendices to the Interim Report. Vol. I. The Interagency Natural Resources Council, Office of the Governor, Austin, Texas. 1971.
- Gunter, G. and H. H. Hildebrand. 1951. Destruction of fishes and other organisms on the south Texas coast by the cold wave of January 28-February 3, 1951. Ecology 32:731-736.
- Hedgpeth, J. W. 1954. Bottom communities of the Gulf of Mexico. p. 203-214. In P. S. Galtsoff (ed.) . Gulf of Mexico, its origin, waters, and marine life. Vol. No. 55. Fishery Bull. No. 89. Fish and Wildlife Serv. U. S. Department Interior. Washington, D. C.
- Hildebrand, H. H. 1954. A study of the fauna of the brown shrimp (Penaeus aztecus Ives) grounds in the western Gulf of Mexico. Institute Mar. Sci. Pub. Univ. Texas, Port. Aransas. 3:232-366.
- Hofstetter, R. P. 1959. Oyster investigation, Galveston Bay; survey of oyster reef populations. Texas Game and Fish Comm. Project No. MO-1-R-1 Report. Austin. p. 1-10.
- Houston-Galveston Area Council. 1972. Regional data Book, Vol. I. (accompanying) Regional Atlas.
- Jeffery, L. M. and J. S. Creager. 1954. Literature survey of the Galveston-Port Arther harbor approach areas. Texas A & M Univ. Project No. 77. College Station. 21 p.
- Jones, R. S., B. J. Copeland, and H. D. Hoese. 1964. A study of the hydrography of inshore waters in the western Gulf of Mexico off Port Aransas, Texas. Univ. Texas. Inst. Mar. Sci. Port Aransas.
- Kimsey, J. B. 1964. Currents on the continental shelf of the north-western Gulf of Mexico. U.S. Bur. Comm. Fish. Biol. Lab. Circular No. 183. Galveston, Texas. p. 25-27.
- Leipper, D. F. 1954. Marine meteorology of the Gulf of Mexico, a brief review. p. 89-98. In P. S. Galtsoff (ed.) Gulf of Mexico, its origin, waters, and marine life. Vol. No. 55. Fishery Bull. No. 89. Fish and Wildlife Serv., U. S. Dept. Interior, Washington, D. C.

- Leipper, D. F. 1954. Physical oceanography of the Gulf of Mexico, its origin, waters, and marine life. Vol. No. 55. Fishery Bull. No. 89. Fish and Wildlife Serv. U.S. Dept. Interior. Washington, D. C.
- Leipper, D. F. 1967. A sequence of current patterns in the Gulf of Mexico. Ref. No. 67-9. Texas A & M Univ. College Station. 38 p.
- Louisiana Wildlife and Fisheries Commission. 1971. Cooperative Gulf of Mexico estuarine inventory and study, Louisiana. Phase I. Area Description. New Orleans. p. 1-130.
- Louisiana Wildlife and Fisheries Commission. 1971. Cooperative Gulf of Mexico estuarine inventory and study, Louisiana. Phase II Hydrology. New Orleans. p. 1-130.
- Lynch, S. A. 1954. Geology of the Gulf of Mexico. p.67-86. In. Galtsoff (ed.) Gulf of Mexico, its origin, waters and marine life. Vol. No. 55. Fishery Bull. No. 89. Fish and Wildlife Serv., U.S. Dept. Interior. Washington, D. C.
- Marmar, H. A. 1954. Tides and sea level in the Gulf of Mexico. p. 101-118. In. P. S. Galtsoff (ed.) Gulf of Mexico, its origin, waters, and marine life. Vol. No. 55. Fishery Bull. No. 89. Fish and Wildlife Serv., U.S. Dept. Interior, Washington, D. C.
- Moore, W. B. (Ed.). 1972. Texas Almanac. News Texan Inc., Dallas. 704 p.
- McGowan, J. H., C. G. Groat, L. F. Brown, W. L. Fisher, and A. J. Scott. 1970. Effects of hurricane Celia--a focus on environmental geology problems of the Texas coastal zone. Geol. Circ. No. 70-3. Bur. Econ. Geol. Univ. Texas. Austin. 35 p.
- National Marine Fisheries Service. 1971. Gulf Fisheries-1968. Current Fish. Stat. No. 5537. U.S. Dept. Commerce. Washington, D. C. 7 p.
- National Marine Fisheries Service. 1972 a. Louisiana landings, December 1971. Current Fish. Stat. No. 5811. U. S. Dept. Commerce. Washington, D. C. 3 p.

- National Marine Fisheries Service. 1972 b. Texas lands, December 1971. Current Fish. Stat. No. 5812. U. S. Dept. Commerce. Washington, D. C. 2 p.
- Nowlin, W. D. 1971. Water masses and general circulation of the Gulf of Mexico. *Oceanology* 6 (2):28-33.
- Nowlin, W. D. 1972. Winter circulation patterns and property distributions. p. 3-51. In. L. R. A. Capurro and J. L. Reid (ed.) Contributions on the physical oceanography of the Gulf of Mexico. Texas A & M Univ. Oceanogr. Studies. Vol. No. 2. Gulf Publ. Co. Houston, Texas.
- Odum, E. P. 1959. Fundamentals of ecology. 2nd ed. Saunders. Philadelphia. 546 p.
- Odum, E. P. 1961. The role of tidal marshes in estuarine production. Misc. Publ. Information Leaflet. New York State Cons. Dept. 4 p.
- O'Neil, T. 1949. The muskrat in the Louisiana coastal marshes. Louisiana Dept. Wildlife and Fisheries. New Orleans. 152 p.
- Orton, R. B. 1964. The climate of Texas and the adjacent gulf waters. U. S. Dept. Commerce. Weather Bur. Washington, D. C. 195 p.
- Osborn, K. W., B. W. Maghan, and S. B. Drummond. 1969. Gulf of Mexico shrimp atlas. Bur. Comm'l Fish. Circ. 312. U. S. Dept. Interior. Washington, D. C. 21 p.
- Parker, J. C. 1971. The biology of the spot, Leiostomus xanthurus Lacepede, and atlantic croaker, Micropogon undulatus (Linnaeus), in two Gulf of Mexico nursery areas.
- Price, W. A. 1954. Shorelines and coasts of the Gulf of Mexico. p. 39-65. In. P. S. Galtsoff (ed.) Gulf of Mexico, its origin, waters, and marine life. Vol. No. 55, Fishery Bull. No. 89. Fish and Wildlife Serv., U. S. Dept. Interior. Washington, D. C.
- Pullen, E. S. 1960. Ecological survey of area M-2 (Upper Galveston and Trinity Bays): A checklist of marsh and marine flora in area M-2. Texas Game and Fish Comm. Project M-2-R-2. Report. Austin. p. 1-5.

- Renfro, W. C. 1959. Basic ecological survey of area M-2 (Upper Galveston and Trinity Bays): Checklist of the flora of area M-2. Texas Game and Fish Comm. Project M-2-R-1. Report. Austin. p. 1-5.
- Shidler, J. K. 1960. Oyster investigations, area MO-1 (all parts - Galveston Bay System and adjacent Gulf beach): Preliminary survey of invertebrate species. Texas Game and Fish Comm. Project MO-1-R-2. Report. Austin. p. 1-15.
- Sprunt, A. 1967. Values of the South Atlantic and Gulf Coast marshes and estuaries to birds other than waterfowl. In. J. D. Newson (ed.) Proceedings of the marshland estuary management symposium. Louisiana State Univ. Div. Cont. Ed. 250 p.
- Thompson, S. H., and E. L. Arnold. 1971. Gulf of Mexico fisheries. p. 200-217. In. S. Shapiro (ed.) Our changing fisheries. U.S. Dept. Commerce. Nat. Mar. Fish. Serv. Washington, D. C.
- U. S. Army. 1970. Report on hurricane camille. Publ. No. 1338. U. S. Army Engineer District. New Orleans, Louisiana. 143 p.
- U.S. Army. 1972. Final environmental statement - crude oil and natural gas production in navigable waters along the Texas coast. U. S. Army Engineer District, Galveston, Texas. 126 p.
- U. S. Fish and Wildlife Service. 1967. Historical catch statistics Gulf states. Current Fish. Stat. No. 4149. U. S. Dept. Interior Washington, D. C. 24 p.
- U. S. Fish and Wildlife Service. 1968. Gulf Fisheries - 1966. Current Fish Stat. No. 4680. U. S. Dept. Interior. Washington, D. C. 8 p.
- U. S. Fish and Wildlife Service. 1969. Gulf Fisheries - 1967. Current Fish Stat. No. 5037. U. S. Dept. Interior. Washington, D. C. 7 p.
- Wathne, F. 1959. Summary of exploratory long-line fishing for tuna in Gulf of Mexico and Caribbean sea. 1954-1957. U. S. Dept. Interior. Fish and Wildlife Serv. Washington, D. C. Comm. Fish. Rev. 21 (4):1-25.
- Wilhelm, O. and M. Ewing. 1972. Geology and history of the Gulf of Mexico. Geol. Soc. Amer. Bull. 83:575-600.

McKann, Mike. 1970. Land Ownership Patterns. In Goodwin, James, T., Mosely, Joe C. (ed.) The coastal resources management program of Texas, appendices to the interim report. Vol. I. Interagency natural resources council. Office of the Governor. Austin, Texas. 1971.

III. ENVIRONMENTAL IMPACT OF THE PROPOSED SALE

A. Introduction

Those who have read previous environmental statements released by this Department for OCS oil and gas leasing will note at least two changes in format and presentation in this section on impacts in the present statement. First, the impacts will be presented approximately in order of potential occurrence: exploration and construction, production, and termination. Second, only potential impacts will be discussed in this section, and no mention will be made of mitigating conditions, circumstances, operating procedures, and regulations. The latter will be discussed in the next major section.

There will also be a separation of impacts on the natural environment and ecosystems and of impact on natural resources and resource uses important to man and the human environment. This is not to say that resources and their use are less important, but it is true that the absence of a healthy environment precludes a healthy and strong resource base. The recognition and separation of impacts on ecosystems and exploitable resources has been aptly described by Dr. Lyle S. St. Amant in a paper presented to the oil industry (St. Amant, 1972). He first describes the

nature of real ecological damage, both long-term irreversible and short-term reversible. He then points out that "In some cases the problem is not ecological since no environmental disturbance occurs. Instead it is a competition for space, reflected in the disruption of navigation or in the difficulty of harvesting the living resources of the marine areas." Thus, these represent conflicts between industries using the Gulf of Mexico for their own profit and should be viewed as such. In no way do they represent a direct impact on the natural environment.

The reader will note in the following impact discussion that all possible types of impacts are described as though they would or could happen if the proposed sale is held. At least two concepts should be kept in mind.

1. This proposed sale is primarily a natural gas sale. Of 129 tracts in the offering, 9 are expected to be oil, or oil and gas prone. Therefore, if all tracts are equally likely to yield producible hydrocarbons, 7% of the exploration and production activity would be for oil, or oil and gas, and 93% would be for gas alone.

2. Even though a given impact resulting from this sale may seem small or unimportant, that type of impact can be additive or cumulative when all leasing in Federal and state waters are considered. Examples are:

- a. Number and distribution of pipelines
- b. Number and distribution of pipeline canals dredged, and concomitant impacts
- c. Amount of non-degradable debris resulting from oil and gas operations
- d. Number of platforms in conflict with commercial fishing and ship navigation.

B. Exploration and Construction Phase

1. Seismic Exploration

In order to locate hydrocarbon deposits, the oil industry must analyze the substructure of the continental shelf. As mentioned earlier in this statement, such structural processes as salt domes piercing or warping overlying petroliferous sediments can cause a pooling and entrapment of commercial deposits of oil and gas.

Subsurface structural features are identified by recording and analyzing the reflections of seismic, or shock waves. These

waves, once generated by dynamite, are now generated by releasing compressed air ("gas guns") and by discharging a spark between two electrodes. The reflections are picked up by a series of hydrophones trailed behind the seismic vessel. Other related bottom surveys include the use of sonar-type instruments to map bottom surface contours accurately and to determine shallow geologic structural hazards which might interfere with drilling operations and platforms and pipeline emplacement. All of these surveys are normally made by companies who perform the service by contract to the petroleum industry.

In January 1969 and October 1970, due to concern about the effect of acoustic energy sources on the ecology of the marine environment, a comprehensive investigation of the effects of compressed air charges on the water column, water bottom and marine life (oysters) was conducted by marine biologists of the Louisiana Wildlife and Fisheries Commission. The experiments were conducted in Sister Lake, Terrebonne Parish, Louisiana, in water depths from three to five feet at two separate locations: (1) hard shell bottom; (2) soft mud bottom. Normal seismic survey operating procedures were used in the tests. The evidence from the tests, as reported by the Commission, indicates no damage to the water, water bottom, or oysters from

the air blasts. (The oysters were examined daily for approximately three months after the completion of the tests for evidence of mortality or abnormality.) General observations indicated that no fish or other marine animals were affected. 1/

Another source of impact, according to a Department of Interior Draft Environmental Statement for a proposed oil shale leasing program (1972), is the noise and exhaust emissions normally associated with diesel powered vessels.

The oil industry collects and interprets geophysical data in advance of contracts for seismic services when the Department issues a call for nominations, in order to intelligently nominate potentially productive tracts, and formulate reasonable bid offers. The Geological Survey also collects and interprets similar state-of-the-art geophysical data to map the structural configuration of the subsurface in the areas of interest, to support tract selection recommendations to support a technical evaluation of the mineral potential of the selected tracts. In addition, the seismic data are used to locate potential geologic

1/ Information provided by Geological Survey.

hazards such as unstable bottom sediments and fault zones.

Therefore, seismic surveys are not only a part of the proposed action, but can also be considered as a part of on-going industrial and governmental petroleum exploration.

2. Exploratory Drilling

If this sale is held, exploratory drilling would be commenced within about thirty days from the date of the sale. Seventeen tracts in the proposed offering are located in waters ranging from 20 to 90 feet deep and the remainder are located in water depths from 150 to 390 feet of water. Shallow (less than 30 feet) water exploratory drilling is commonly carried out using a "jack-up" type drilling rig, while deeper waters require the use of semi-submersible or floating rig. The former is emplaced by being towed into position and having legs jacked downwards to contact the bottom and lift the platform 20 to 30 feet above the water surface. The latter is held in position by several anchors. On semi-submersible or floating rigs a submarine blowout preventer is lowered to the sea floor over the exact drilling site. Following this, actual drilling would begin. It may be necessary to drill from 5 to 8 wells to determine the extent of hydrocarbons in place. This is necessary because of the extreme expense of deeper water platforms and the economic necessity of drilling as many production wells as possible (sometimes over 30) from a single platform. Platform location in relation to hydrocarbon deposits must be extremely accurate to minimize installation of platforms.

The potential and predictable impacts resulting from these activities are many:

a. Drilling Rig Emplacement

(1) Impact on Resources and Their Use

(a) Impact on Fishing

Both commercial and sport fishermen would be denied use of the ocean in the immediate vicinity of the drilling rigs and commercial trawl fishermen would also be excluded from the area occupied by the anchoring system of semisubmersible rigs. This could amount to 2 to 5 acres of ocean surface for jack-up rigs or up to 325 acres (assuming a 1500' anchoring radius) for semisubmersible rigs in the case of commercial trawl fishermen. The duration of exploratory, drilling ranges from under 45 days for a single well to around six months for multiple well explorations.

(b) Conflict with Ship Navigation

In all seas adjacent to the United States, including the Gulf of Mexico, safety lanes, or fairways, have been established for the safe passage of vessels enroute to or from U.S. ports. However, an unknown number of ships do not use these fairways, greatly increasing the possibility for a collision with drilling rigs and their attendant vessels.

Impacts which could result include loss of human life, a spill of oil, release of debris including parts of, or the entire drilling rigs, and the ship, if it sinks. The contents of the ship's cargo could pose a serious threat to the environment if it includes toxic materials such as chemicals, crude oil, or refinery products.

(c) Aesthetic Impact

If air quality permits unlimited visibility, some portion of a one hundred foot structure can be seen from the beach if it is located seventeen miles or less from shore. Some people consider the sight of offshore equipment aesthetically unpleasant.

b. Debris and Pollutants Other than Oil

In the course of normal exploratory operations, several types of debris will be accidentally lost into the ocean.

(1) Sinking Metallic and Non-Degradable Material

Included in this category are a myriad of forms ranging from large pieces of machinery that might be lost off a barge to smaller items such as welding and cutting debris, tools, and mousing wire.

(a) Impact on Natural Environment

Smaller, reflective pieces of metal such as pull-tabs on beverage cans are known to be ingested by some fish as they settled through the water. The tabs frequently injure the gut and lead to the death of the fish.

(b) Impact on Resources and Uses

Large pieces of debris could become entangled in, or even damage, the trawl nets of commercial fishermen.

(2) Soild Waste--"Trash"--Including

-- Floating metallic and non-degradable material (e.g., empty drums, cans, barrels, etc.)

-- Floating non-metallic and non-degradable materials (e.g., plastic, and foam flotation materials, rope, woods, etc.)

-- Floating non-metallic and degradable materials (e.g., kitchen waste, paper products, cardboard, fiber board, etc.).

All solid waste accumulating from daily drilling and production operations is collected in large containers constructed of heavy grating. To reduce the bulk before being transferred to

shore, wastes are sometimes compacted in mechanical compactors but are generally incinerated in burn baskets suspended from the platform. Ashes are allowed to fall into the water. Non-combustible solids are then loaded into service boats for transfer to shore.

Solid wastes, transferred to shore, are emptied into municipal or private sanitary landfills which are subject to the sanitary landfill laws of the State.

Heavy winds, however can blow paper, plastic, or cloth materials out of the collection containers and off the platform.

(a) Impact on Natural Environment

The burning of this "trash" would result in a small contribution to air pollution.

(b) Impact on Resources and Uses

Any floating material cast up on the beach or washed into a bay would constitute an impact upon the aesthetic values for users or owners of the area. These materials also constitute a hazard to boats. Damaging collisions can result between small fast boats and floating drums, cans, wood. The screws of all sizes of motor boats and vessels can

be fouled on floating plastic sheeting and plastic or nylon ropes.

(3) Diffusible or Degradable Toxic Liquids (e.g., paint, fuel, solvents, motor oil, etc.)

Some of these materials could also be lost into the sea. Ordinarily, the amounts involved would be so small, according to available information, that the impact would be very minor. However, if a drilling rig or fixed structure caught fire or collapsed into the sea all of the toxic liquids stored on-board could be released into the environment. The impact in this case might be similar to that described for oil pollution presented later in this section.

(4) Sinking or Diffusing Non-Metallic and Non-Degradable Materials (e.g., drilling muds, mud additives, oil well cement, drill cuttings, and sand)

Drilling muds are not normally dumped off exploratory drilling rigs, but are continuously cleaned and re-used. Some muds, however, are dumped after completion of production well drilling and will be discussed in the section devoted to impacts from the production phase.

Drill cuttings and well sand, after being cleaned of oil, are deliberately dumped and allowed to settle to the ocean floor.

However, there are no known impacts resulting from this dumping either to the natural environment or to resources and other uses. Likewise, there is no known effect from the loss of small amounts of oil well cement.

c. Blowouts

In normal drilling operations, the weight of the column of drilling mud is monitored and controlled so that its resultant pressure is always greater than the natural reservoir pressures encountered. In the event that a sudden, unexpected pocket of high pressure is encountered, the insufficiently heavy mud would be forced upward and an uncontrolled release of gas, oil, or water could ensue if proper well control measures were not taken. However, a second line of defense employed by drillers against such costly and dangerous accidents is the blowout preventer. In an oversimplification, this consists of a very large and powerful, semi-automatic valve assembly sitting atop, and attached to, the well-head casing on the ocean floor. It can be optimally actuated within seven seconds (ESSO Production Research Company, 1972) of the perception of an emergency situation. It functions by completely blocking the space between the well-head casing and the drill string.

In the event the blowout preventer system also fails or has not been used, an actual blowout occurs. Most fires have been associated with production operations (Chevron, 1970 fire and spill; Shell, 1970-71 fire and spill) and not exploratory drilling. However, exploratory well blowouts can also be ignited and present a dangerous situation for the crew, equipment and environment.

In the event a blowing oil well is ignited, it is usually allowed to burn while operations are underway to control the wild well from a remote location. In this way, a high percentage of the hydrocarbon liquid expelled by the well is burned and little ocean pollution results. The impact would consist mainly of a severe degradation of local air quality.

If the wild well is releasing only natural gas, ocean pollution cannot occur even if the flame is extinguished, so efforts to put out the fire are usually begun immediately. Whether or not a fire results, a blowing gas well would also result in much less air pollution than would occur from a burning oil well. If the gas well was burning, combustion would be almost complete, and the amount of particulate materials and monoxides of carbon would be low.

(1) Impact on Air Quality

According to one authority 1/ the average composition of Natural Gas as delivered to pipelines in the U.S. is

Methane	CH ₄	72.3%
Ethane	C ₂ H ₆	14.4%
Carbon dioxide	CO ₂	0.5%
Nitrogen	N ₂	12.8%

(Small amounts of sulfur could also be present in some localities.)

If the wild well were not burning, obviously the above gases would be released into the air. If the well was on fire, the emissions would consist almost entirely of carbon dioxide (CO₂) and water; the nitrogen would remain as N₂ and any sulfurous gases would be oxidized to SO₂. The resulting impact would be slight.

A reasonable estimate of the range of emissions, assuming complete combustion, that an oil well fire could produce per 1,000 bbl. burned, might be as follows 2/:

1/ Henry A. Ley. "Natural Gas", in Geology of Natural Gas, Amer. Assoc. Petrol. Geol. Tulsa, Okla (1935) pp. 1073-1149. as cited by Levorsen (1958).

2/ Values used in calculation are based on world averages for crude oil of 310 lb/bbl.; Percent content by weight is: carbon - 82.2 to 87.1, sulphur - 0.1 to 5.5, nitrogen - 0.1 to 1.5 (Levorsen, 1958).

CO₂ : 340,000-347,000 lb.

SO₂ : 620-34,000 lb. 1/

NO : 660-10,000 lb.

(As a point of reference, during the Chevron - 1970 fire and spill, the maximum spillage rate was estimated to be 1,000 bbl. per day.)

Combustion of oil would in reality be incomplete, however, and emission would contain somewhat less of the above compounds, but would include, in addition, such materials as volatilized petroleum, particulate carbon, carbon monoxide, nitrous oxide, sulphur monoxide, along with other altered or partially oxidized matter. There is no reliable way to predict in advance the relative volumes of each of these possible emissions because it would depend, among other things, upon moisture content of the air, wind speed, pattern of oil spray from wild wells, number of wells involved, chemical content and physical character of the oil itself, and types of equipment and materials other than oil that might also burn.

1/ SO₂ emission would be less for Gulf of Mexico crudes, which range from 0.1 to 0.5% sulphur.

All oil well blowouts do not result in fires. In fact, the nature of some blowouts almost preclude a fire. For instance, the Santa Barbara Spill of 1969 emanated from a fissure in the ocean floor and never sprayed into the air, but surfaced beneath, or at some distance from the platform (Reinhart, 1970).

All oil spills into the ocean have certain features in common. Escaping oil forms a conspicuous plume on the water surface, extending generally in the downstream direction of the surface current, but is also sensitively influenced by the wind shear acting directly on the oil surface. In studying the path of the oil plume extending from the 1970 Chevron spill off the Mississippi Delta, Sonu, Murray, and Smith (1971) found that the correlation between the wind vector and the slick was higher during times of strong winds (i.e., over 15 mph) and of steady wind direction. They also found, on the basis of a few assumptions, the oil plume geometry could be explained by a simple diffusion model.

After the oil has spread upon the sea surface, several physical phenomena act upon it. Probably the most mitigating, environmentally speaking, is evaporation, which permanently removes it

from the ocean. Dr. Carl Oppenheimer 1/ described an experiment in which he found the volatility of Gulf crudes to range from 24.0 to 84.8 percent by weight, with a mean loss of 44.2 percent. Based on the mean loss value, a 1,000 barrel spill might optimally lose 137,020 lb. of crude oil to the atmosphere. These figures represent laboratory conditions; an estimated 15% evaporation during the Chevron spill in 1970 was considered extremely high for oil on the sea.

Another force acting on spilled oil is turbulent mixing, which changes it from a surface slick to finely divided particles of oil in the water column. Probably, the largest proportion of the dispersed oil reaches the bottom and is incorporated into the sediments.

(2) Impact on Open Ocean - The Oceanic, Neritic, and Benthic Communities

Even if large amounts of spilled crude oil are carried over the outer continental shelf and toward the deep ocean, sufficient dispersion and dilution would occur so that the oil would probably be undetectable, even by the most sensitive means of analysis. However, in the open sea, bacterial

1/ Exhibits presented at OCS Public Hearing, August 23, 1972. New Orleans, Louisiana.

degradation is very slow, owing mainly to low levels of nitrogen and phosphorus nutrients in the sea water, and extensively weathered particulate crude oil floating near or at the surface may remain for some time.

In terms of the proposed sale, nine tracts are thought to be oil, or oil and gas, prone and all lie within 28 miles or less of the shore. Oil spilled from these tracts would be introduced into the inner continental shelf waters, the shoreline features, and the shallow sublittoral benthic regions.

While the spilled oil is still in the form of a slick, its primary impact is on pelagic birds. Shelton (1971) states that "The causes of death of oil-contaminated birds are usually complex. Clogging of plumage greatly reduces its insulating properties, while ingestion of oil during preening can cause a variety of pathological conditions including severe enteritis with necrosis of the duodenum... This, in combination with increased heat losses, may reduce feeding activity and a marked drop then occurs in the fat reserves of the bird, followed by muscular emaciation. It is in this critical condition that most oiled birds arrive on the shore, where further stresses are placed upon them by cleaning and attempts at rehabilitation.

It is not therefore surprising that the mortality rate at cleaning centers is normally very high indeed."

The table on the following page lists oil spill-related bird mortalities as noted in the literature.

As stated previously, most of the oil will be dispersed as minute droplets in the water. Here they have the opportunity to damage marine organisms and enter the marine food chain. Hufford (1971) notes laboratory studies which indicate oil can affect phytoplankton after several days exposure. He cites laboratory experiments in which oil products in sea water cause lack of cellular division and death in phytoplankton during five days' exposure at levels of 0.1% or less. Apparently, cellular membranes were damaged by the penetration of hydrocarbons and this led to the extrusion of the cellular contents. During a study of the effects of the Santa Barbara spill, however, Oguri and Kanter (1971) found no conclusive evidence of a decrease in phytoplankton community productivity that could be attributed directly to the oil spill. Individual experiments indicated, however, that the use of dispersants may have resulted in marked reductions in productivity. They theorized that the longevity

No. Birds Affected	Source of Spill	Material Spilled	Location	Year	
3,600	Platform	crude oil	Santa Barbara, Calif.	1969	*
200	not specified	diesel oil	Firth of Forth, Scotland	1969	**
9,000	not specified	fuel oil	Aberdeenshire, Scotland	1970	**
1,000	not specified	"Oil"	Southwest England	1970	**
12,000 (Contaminated)		fuel oil	Northeast England	1970	**
1,000 (Contaminated) Tanker			Southern England	1970	**
2,300	Tanker <u>Arrow</u>	Bunker C	Chedabucto Bay, Nova Scotia	1970	**
none	Platform-Chevron	crude oil	Offshore Louisiana	1970	**
1,000 (Contaminated)	Tanker <u>Delian Appollon</u>	Bunker C	Tampa Bay, Florida	1970	**
1,000	not specified	weathered oil	Martha's Vinyard, Mass.	1970	**
96,000	not specified	"Oil"	Kodiak and adjacent Is., Alaska	1970	**
none	Shell Platform	crude oil	Offshore Louisiana	1970	***
6,000	Tankers-Standard Oil Co.	Bunker C	San Francisco Bay, Calif.	1971	****
none	Amoco Platform	crude oil	Offshore Louisiana	1971	***

* Straughan, 1971a. ** Environment Editorial Staff, 1971.

*** Testimony of Dr. Carl Oppenheimer, OCS Public Hearing, New Orleans, Louisiana, Aug. 23, 1972.

**** Chan, 1972.

of any such effect would depend on the currents and rate of dilution, as well as the type and quality of the dispersant. No evidence was found in the literature that spilled oil enters the marine food chain via adsorption or absorption by phytoplankton and subsequent ingestion by grazing herbivores.

Little information has been found concerning the effect of crude oil on the zooplankton. Hufford (1971) cites one experiment which showed accelerated death of zooplankton exposed to diesel oil (0.1% for 5 to 60 minutes) as compared to non-exposed zooplankton. Zooplankton have been observed to ingest spilled Bunker C oil particles, however, with no apparent effect. Members of the Operation Oil (1970) task force, studying the effects of spilled Bunker C from the tanker Arrow in Chedubucto Bay, Nova Scotia, observed that many copepods in the area had apparently ingested small oil particles and 2.4% Bunker C was found in the feces of one species. They noted that animals containing smaller oil particles voided these within 24 hours and showed no signs of distress. That they continue normal activities with no apparent harm is quite important in consideration of the marine food chain, because they can be eaten by small fishes and filter-feeding organisms while carrying the oil in the gut.

These in turn may be eaten by large predatory animals and thus all conditions are present for a classic example of biological magnification of a potentially harmful or toxic compound.

Studies of the physiological effects of crude oil on fish are apparently rare, as none could be found. Hufford (1971) cites several early studies which show that crude and bunker oils harmed or killed fish eggs in laboratory experiments. He also cites Mironov (1970) who found that oil affects fish respiration by clogging gills and damaging gill tissue. A more common (and easier) approach to studying the effects of oil on fish is to expose them to varying amounts of oil in a laboratory aquarium (e.g., Spears, 1970) but this is of little value in assessing the impact of spilled oil in the ocean because of the vast difference between an aquarium and the ocean and the fact that oil concentrations in the water during a spill are rarely known. No information has been found on the effect of spilled oil on other mobile swimming animals such as shrimp and squid that occur in the Gulf of Mexico.

Probably because of the relative ease of sampling and because of their immobile nature, some research has been performed on the effect of oil on the benthic community. This is important

because most spilled oil, after being dispersed into the water as droplets, adheres to particulate matter and sinks where it comes into direct contact with the ocean floor. But, because nearly all of these studies were performed in the shallow waters of the immediate subtidal area, the littoral or intertidal, and in bays and estuaries, this discussion should be included in the next section which follows immediately below.

(1) Impact on Areas Near the Shoreline--The Shallow Subtidal and Littoral Areas, Bays and Estuaries, and Marshes

When an oil spill occurs relatively near the shoreline, as most have in the past, large concentrations of dispersed oil and even oil slicks can be deposited in the areas associated with the shore.

(a) Impact on the Shallow-water Subtidal Areas

Through the action of surf and associated turbulence, oil slicks reaching coastal areas are broken up fairly rapidly and are deposited on the bottom and in the sediments. Here it comes into contact with the extensive and highly productive sublittoral benthic communities briefly described in section II.D.2.b. An example of this rapid sinking can be noted in the study of Mackin and Sparks (1962) in which a wild well discharged oil which spread over bayous and small bays west of

the Mississippi Delta near Barataria Bay. One month after the spilling was controlled and slicks had largely disappeared from the water surface, they found, "...in tonging oysters... oil was dislodged from the bottom and floated to the surface in considerable amounts."

One study of the effects of oil on subtidal benthic communities is that of Fauchald (1971), carried out to determine possible damage caused by the Santa Barbara spill. One of the major organisms studied was a frequently occurring marine worm, Listriolobus pelodes (not present in northwestern Gulf of Mexico). After considerable sampling, Fauchald concluded, "There are no indications that it has been totally exterminated or even reduced markedly in the vicinity of Platform A. In fact, in one of the box cores taken in October, 1969, as part of the bacteriological survey, a relatively small, but otherwise normal, L. pelodes was found sitting in its shallow depression surrounded by an inch-thick layer of black mud mixed with crude oil." The author theorized that fluctuations in numbers of benthic animals observed may have been due to natural causes or oil well drilling activity in the area, or the oil spill or sewage pollution, but states that no effects directly attributable to the oil spill could be seen. The author qualified this, how-

ever, by mentioning that with the technique used it was not possible to separate the effects of the oil spill from the general background "noise" of other factors influencing the benthos. In the Arrow spill study (Operation Oil, *ibid.*), lobsters appeared to be clean and normal in behavior. Scallops taken near heavily oiled beaches, were cooked and eaten and had no oily taste, but chemical analysis of scallops, along with periwinkles, sea urchins, and other bottom dwelling organisms revealed that oil was present in the digestive tract, other organs, and muscle tissue. A species of fish was found to have oil in the feces but not on the gills.

Data of Sanders, Grassle, and Hampson (1972) show immediate and nearly complete mortality of many forms of benthic animals following the spill of No. 2 fuel oil near West Falmouth, Massachusetts. The bivalve molluscs (clams, etc.) seemed especially vulnerable. As a rule, when concentration levels of oil in the sediment apparently decreased below a certain level, with the passing of time, affected areas were recolonized by resistant forms, especially the marine polychaetous worm Capitella capitata. This generally within three to six months from the initial oiling. With the passage of about 10 to 12 months, the more sensitive molluscs resettled many areas.

However, at some harbor stations apparently receiving a heavy oiling, some highly sensitive forms such as the ampeliscid amphipods had not returned. Farther offshore, this required about six months.

Chemical analysis of edible shellfish species made following the West Falmouth spill revealed that the fuel oil had been absorbed or ingested and could subsequently be found in oyster bodies and scallop muscles in quantities sufficient to close shellfish beds to harvesting (Blumer, Souza, and Sass; 1970). It is especially significant that contaminated shellfish elicited no oily taste when eaten--which sheds considerable doubt on the practice of determining pollution levels by taste tests, as is common in many areas.

(b) Impact on Beaches and the Intertidal Zone

All shorelines in the northwestern Gulf are sandy to muddy; there is no natural rock in the area, and the tidal range is small, approximately 2 feet.

A study of three sandy beaches oiled during the Santa Barbara spill (Trask, 1971) revealed no conclusive results concerning the impact on marine fauna. Severe beach erosion in early

spring (a common feature of Pacific beaches in winter and early spring) removed oil pollution, large amounts of sand, and much of the associated fauna and rendered definitive evidence of any possible impact unobtainable.

During the Arrow spill study (Operation Oil, 1970), excavation of clams revealed oil extending down most burrows and often forming a pool at the bottom. Clams generally moved up the burrow to evade the pools, and sometimes left the entire substrate. Some mortality occurred and even the live clams were unresponsive, although they recovered with prolonged exposure to air.

Other pollution studies for the littoral zone are concerned with rocky shorelines and their characteristic assemblages of seaweeds, barnacles, limpets, anemones, etc. and bear little relationship to conditions in the Gulf of Mexico except for consideration of physiological stresses leading to death in oiled plants and animals. To generalize, where organisms have been covered by crude oil and Bunker C fuel oil, death is primarily blamed on smothering due to the physical coating, (e.g., Chan, 1972; Nicholson and Cimberg, 1971). When the pollutant has been a lighter refined oil (No. 2 fuel oil, diesel fuel), death and stress has been associated primarily

with toxic effects of the oil (e.g., North, Neushul, and Clendenning, 1964; Texas Instruments Inc., 1971).

(c) Impact on Bays, Estuaries, and Lagoons

Oil pollution in these semi-enclosed waters can be more serious than that in the sea or along the open coast line because the pollutant is relatively entrapped with tidal flushing being its only source of removal and because many species undergoing early development in estuarine waters are vulnerable to even small quantities of toxic compounds containing oil. On the other hand, if the semi-enclosed body has a large volume of freshwater discharged into it, net outflow may be great enough to physically block the entrance of oil. In an early study of bay and bayous pollution, Mackin and Sparks (1962) noted that oiling of oysters by a wild well had no effect so far as survival was concerned. Mortality in oiled oyster beds was not statistically different from that in unoiled beds. Their data also showed that potential stress to the oysters by oiling did not increase the incidence of infection by a common oyster pathogen, Dermacystidium marinum. Mackin and Sparks may have erroneously judged the oysters to be free of petroleum contamination however, by using a taste-test of the oysters as the sole

criterion for judgment. Zitco and Carson (1970), as cited in the Chedabucto Bay pollution by the Tanker Arrow noted oil in the muscles, gut, and other organs of scallops which had no oily taste. Blumer (1971) has stated "unfortunately, chemical analysis (of potentially contaminated edible species) has not been used to support...studies in the past and conclusions on the persistence of oil in the environment have been arrived at solely by visual inspection... Marine foods may be polluted by petroleum and may be hazardous to man but neither taste nor visual observation may disclose the presence of the toxic hydrocarbons."

Besides Mackin and Sparks (1962) study, no others are available which treat conditions even remotely similar to pollution in semi-enclosed waters of the Gulf of Mexico. The Chedabucto Bay Arrow spill and West Falmouth-Buzzards Bay incidents have already been discussed. The Tampico spill in 1957 released 55,200 bbl. of No. 2 fuel oil into a small marine cove of Baja, California. The oil lost was contained in the cove, resulting in the immediate kill of all forms of marine life, and recovery to pre-spill conditions was estimated to be approximately 6 years, although sub-lethal effects may have persisted longer (North, et. al., 1964).

(d) Impact on Marshes

Many Gulf Coast bays and much of the northern seashore are fringed with marshes and are extremely vulnerable to spilled oil. One study of salt marsh oiling followed a "moderately severe" spill of crude oil in Milford Haven estuary, Wales (Baker, 1971). The author found that two weeks after the spill, oily salt marsh vegetation has turned yellow and was dying, but new green growth was showing at the base of some species. One year later there were still dead patches in some communities but weedy annuals were colonizing these patches. No observations were made of salt marsh fauna, but it could be expected that all infaunal and aquatic species would be killed in the area affected by the spill. Most likely a marsh spill would not spread far because of the physical hindrance due to emergent rooted vegetation, natural stream levees and canal spoil banks.

Oppenheimer and Gordon (1972) state that dunes which are created on the open shore may be as high as forty feet above sea level, although they average between five and fifteen feet. Thus, marshes are so remotely situated from potentially oil productive tracts, that a spill resulting from well blowouts and platform

accidents could not reach them. A storm surge associated with a hurricane could cause sea level to exceed the height of the beach ridge, but the extreme turbulence would disperse spilled oil over an extremely wide area, and would probably prevent a concentration in any single location. Thus, it is thought that no marsh impact would result from spilled oil under these conditions.

A pipeline break and oil spill in the marsh is a very real possibility however, and will be discussed in the section devoted to impacts from pipeline.

(4) Impact on Resources and Their Use

(a) Commercial Fishing

Commercial fishermen would be unable to fish in the vicinity of a spill (and/or fire) due to emergency control and containment activities. They would also not be able to fish in the vicinity of oil slicks, even if remotely located from the site of the spill because of the possibility of fouling both gear and catch with oil.

Fish which are either externally coated or internally contaminated with oil are unmarketable. It has been shown that fish that live in the vicinity of chronic spillage are likely to be

internally contaminated. Ehrhardt (1972) has found that oysters taken near the entrance of the Houston Ship Channel in Galveston Bay, Texas are contaminated with a high content of petroleum-derived aromatic hydrocarbons. Because aromatic hydrocarbons are much more soluble in water than paraffinic and naphthenic hydrocarbons, the oysters most likely take up the aromatic fraction as a watery solution through their gills and, being filter-feeders, as particulate matter. The author found the composition of the oyster contaminant to be similar to many Texas crude oils, among them Conroe, Beaver Lodge, and Lee Harrison. Connell (1971) has shown that a kerosene-like tainting in Australian mullet is due to the presence of kerosene-like hydrocarbons in the flesh. He found the contaminating compounds to be similar to substance isolated from river sediments, and that government Fish Board condemnation records show that periods of condemnation coincide with periods during which mullet have just left the estuaries and large catches are made. The river used by the mullet flows alongside oil refineries and associated storage and wharf facilities. Volatile hydrocarbons were found in the water adjacent to petroleum storage facilities and also in the river's estuary near a sewage outfall.

Scarratt (1971) has found that commercial species of scallops ingested spilled Bunker C oil. Subsequent chemical analysis revealed the presence of Bunker C in the mantle, digestive gland, adductor muscle, and gonad, leading to the conclusion that the scallops had assimilated the ingested Bunker C oil.

(b) Recreation

Water sports, such as swimming, diving, spearfishing, underwater photography, fishing for finfish and shellfish, boating and water skiing would also be directly affected by an oil spill.

Other marine related activities such as beachcombing, shelling, painting, shoreline nature study, camping and sunbathing, would be made much less attractive for an indeterminate period where an oil spill had coated a beach.

(c) Historical and Archeological Sites and Objects

Besides physically coating such sites and objects, oil, penetrating into specimens, might interfere with radiocarbon dating.

d. Termination of Exploratory Drilling

If oil and gas are not found in quantities that would be profitable to produce, the well is abandoned and the

site cleared in accordance with procedures and regulations to be described later in this statement. Beyond abandonment, no continued impact would result to either biological communities or resources and their use.

If petroleum deposits prove to be of a profitable size, one of two courses of action may be followed.

(i) The exploratory well may be deemed unsuitable for production and permanently abandoned. Impact would be the same as above.

(ii) The well may be deemed satisfactory for future use as a production well and temporarily abandoned. In this case, a mechanical bridge plug is emplaced in the smallest string of casing and the well head capped and left for future entrance when production activity commences. This results in existence of an underwater "stub". Coast Guard regulations require that such a stub be marked by a buoy at the surface, but sometimes the buoy is torn away by waves or is removed by other unknown means.

(1) Impact on Resources and Their Use

A commercial trawl fisherman can damage, destroy, or even lose an expensive trawl by catching it on an unmarked underwater stub.

Even if the buoy is in place, a small area of ocean floor is unavailable to a trawl fisherman because he must avoid trawling near it because of the danger of the net becoming entangled on it.

3. Construction of Permanent Platforms and Pipelines

After exploratory procedures have resulted in the discovery of oil and gas deposits of a profitable size, plans are formulated for the construction of permanent production platforms and pipelines.

a. Permanent Production Platforms 1/

These structures are built by construction companies specializing in such items under contract to the petroleum producers. The platform is generally fabricated in two pieces at a shore-based facility according to design specifications of the petroleum producer. The two component pieces, the upright tower and the upper, horizontal platform, are then towed or barged to the production site. The tower is emplaced by controlled flooding and sinking of the lower end of the tubular legs. The horizontal platform is then lifted into place on top of the tower and welded to it. The drilling tower, power plants, generators, living quarters, storage sheds and other components, constructed in modular form, are added to the platform, and production well drilling commences.

1/ "Permanent" = Producing life of the oil or gas reservoir.

(1) Impact Resulting from the Placement of Platforms

The resultant impacts would be the same as those described for the placement of drilling rigs, except perhaps that less area of trawlable ocean floor would be used by the permanent platform because there are no anchoring-mooring systems used and because service boats and barges would be present less often.

b. Fabrication and Laying of Pipelines

After estimates of producible oil and gas have been made, based on exploration data, plans for pipeline construction are formulated. In connection with the present proposal, a canvass of industry representatives has revealed that at the most, three new major pipelines will be needed to transport exploitable reserves to shore from this proposed sale. In addition, short spur lines would be required to connect individual platforms to main pipelines.

These pipeline requirement projections are based on the depleting nearshore production, anticipated capacity of existing trunklines to shore and the fact that the economics of production from deep-water, distant offshore areas requires group efforts to bring oil and gas ashore.

All offshore pipelines are fabricated by welding sections together on a barge while simultaneously moving the barge forward and allowing the completed expanse of pipeline to sag downward and lay on the bottom.

In water depths greater than 200 feet, nothing further is done with the pipeline except to use it in transporting produced oil or gas.

In depths under 200 feet, present OCS administrative procedures require burial of the pipeline. Burial is effected by jetting sediment away from underneath the pipe and allowing it to sink into the resulting trench. No attempt is made to fill the trench and cover the pipeline, because over a period of time, settling and reworking of sediment by underwater currents, buries the pipeline. In much of the continental shelf in the Gulf, even unburied pipelines eventually sink into the soft underlying sediment, and are thus buried, but this phenomenon may require months to years to take place.

As the pipeline construction approaches and transgresses the shoreline, it is buried deeply enough to avoid its being exposed by storm-associated beach erosion. From this point the pipeline construction will be extended toward a storage

facility, or a major existing pipeline system leading to a storage facility or a refinery. Before the new pipeline reaches its inland terminus, it may cross agricultural or grazing lands, sand dunes and flats, salt marshes, bays, stream courses, and freshwater marshes. Where pipelines cross firm soil or sand, and inland waters such as bays and stream courses, it is normally buried by entrenching and backfilling. However, in coastal marshes it is only possible to bury pipelines and back-fill the canals when bottom soil conditions are suitable to make such a process feasible. In many instances, especially involving larger diameter pipelines, it is not possible, given the physical consistency of the substrate, to bury them. In these instances canals dredged for pipeline emplacement are left open.

(1) Impact on Fabricating and Laying Pipeline in the Continental Shelf in Waters over 200 Feet Deep

(a) Impact on Natural Environment

This activity would have no impact on the environment.

(b) Impact on Resources and Their Use

It has been reported 1/ that unburied pipelines pose a serious problem to trawling operations. The

1/ Testimony of James C. Farrelly, President, Louisiana Shrimp Association, presented at August 23, 1972, OCS Public Hearing, New Orleans, Louisiana.

following statistics show that a considerable proportion of the Texas shrimp catch is harvested from deeper waters.

Texas Shrimp Harvest by Depth 1/

<u>Year</u>	<u>Depth, Feet</u>	<u>Species</u>	<u>Approximate Proportion of total Catch</u>
1967	126-360	Brown	30%
	126-210	Pink	
1968	126-450	Brown	19%
	126-240	White	
1969	126-270	Brown	25%
	126-240	White	
1970	126-360	Brown	24%

It can be concluded that a significant amount of shrimp trawling does occur in water depths where pipelines remain unburied.

(2) Impact of Fabricating and Laying Pipeline
on The Continental Shelf in Waters Ranging
from 0-200 Feet Deep

(a) Impact on the Natural Environment

As stated above, pipelines at this depth are entrenched by jetting away the sediment beneath the pipe and allowing it to settle into the underlying trench. Subsequent burial is allowed to take place naturally, primarily by reworking of sediments by bottom currents.

1/ Computed from data presented in U.S. Fish and Wildlife Service 1968, 1970; National Marine Fisheries Service, 1971a, b.

The jetting process physically disrupts the sediments in its path completely and also causes resuspension of large quantities of sediment.

Most, if not all benthic infauna and sessile epifauna are either destroyed by the jetting or raised into the surrounding water and rendered completely vulnerable to predation. Although recolonization would begin immediately, the endemic fauna could not be fully restored until seasonal reproductive cycles had been completed by representative species from adjacent areas, which would provide a supply of larvae to settle and enter the reworked substrate.

Turbidity resulting from resuspended sediment is capable of inflicting an adverse impact on filter-feeding apparatus or blocking respiratory surfaces. However, casual observation has revealed that ocean currents carry the sediment away and redeposit it at varying distances away, depending upon the particle size of the sediment. No information could be found concerning adverse impacts which might result from these offshore pipeline laying operations.

Another possible source of impact is the resuspension of toxic heavy metals and persistent pesticides that may have been deposited in the area by a polluted stream and runoff, but here too, ocean currents would likely dilute and disperse such materials.

(b) Impact on Resources and Their Use

If spoil banks are created during the jetting operation, they could interfere with trawling operations but no evidence has been found which indicates this has ever been a problem. Also previously undiscovered archeological or historic objects, such as sunken ships, could be damaged.

(3) Impact of Fabricating and Laying Pipeline Across the Beach, Foredunes and Barrier sand flat

(a) Impact on the Natural Environment

If redistribution of sand by wind was a problem in an area, the devegetation of the pipeline corridor could result in beach and dune erosion. This could be prevented by a concerted and expedient revegetation program. However, no evidence has been found that this condition could exist along the upper Texas coast.

(b) Impact on Resources and Their Use

Even after burial of the pipeline, the scars will cause a considerable impact on the aesthetic values of the

beach and associated dunes and sand flats. After a period of time has passed, the sand will be redistributed by wind and rain, and revegetation should be complete within a single growing season. Also previously undiscovered archeological or historic objects or sites could sustain damage.

(4) Impact of Fabricating and Laying Pipelines
Across Coastal Zone Waters: Bays and Estuaries

(a) Impact on the Natural Environment

Impacts could result from high turbidity during dredging and jetting, resuspension of toxic heavy metals, and from physically obliterating organisms in the path of the pipeline and its corridor where laying and burial take place.

A number of studies on the effects of turbidity caused by dredging in bays and estuaries have been carried out. Luntz (1938), as reported by Ingle (1952), studied the effects upon oysters of dredging operations in relatively shallow bays and lagoons. Ingle stated: "Intermittent and continual observations made by him (Luntz) indicated that dredging operations in no way increased the mortality of oysters in the sections studied. Further studies in the vicinity of dredges in operation showed that oysters were able to survive in the turbid waters created by the dredges in the

canal prism of the Intracoastal Waterway. Experiments conducted within the right-of-way showed that 94% of the oysters were able to survive even when suspended in spill water from dredge discharge, and were killed only when actually buried by spoil." Luntz also noted that dredging operations apparently had no influence on spawning and setting.

Ingle's (ibid) study, concerning the effects of dredging in Mobile Bay, Alabama, revealed that when oysters were suspended from the stern of the dredge, no significant mortality occurred. He also found that burial by up to one inch of mud caused no apparent harm to the oysters.

After making the above findings about oysters and studying the abundance of a variety of finfish, shrimp, crabs, squid, and clams, he concluded: "It can be stated without equivocation that the findings of this study failed to show a single instance of deleterious action to estuarine animals resulting from the operation of a dredge." He also commented that: "Although no deliberate attempts to discover beneficial influences in dredging were made, certain observations made in this study seem to support this idea. Oysters fattened quickly in finely particulate and suspended material; commercial shrimping operations centered in the general area surrounding active dredges."

Adverse effects have been noted on several species of marine animals during aquarium studies when turbidities were kept artificially high by constant recirculation (vis. Cobb, 1972; Wallen, 1951; Herbert and Merkens, 1961).

In another study concerning extensive dredging and spoil deposition (much greater than would accompany pipelines) for a Chesapeake Bay ship channel, the following observations were made (Cronin, 1970):

(i) "No gross effect of dredging or spoil disposal was observed on phytoplankton primary productivity, zooplankton, fish eggs and larvae, or fish..."

(ii) "There was a reduction of about 70% in the average number of benthic individuals per square yard and of about 65% in the benthic biomass in the spoil disposal area, accompanied by a marked reduction in the number of species present. After one and a half years, numerical abundance, biomass, and species diversity

had recovered to approximately the pre-disposal levels." (The spoil material covered the bottom to a depth of a least one foot.)

Resuspension of toxic heavy metals during dredging and jetting operations was mentioned as a possible source of impact in the ocean, but was not considered in detail because of the extremely remote possibility of harmful concentrations building up before it would be dispersed and diluted by ocean currents. In a bay with a past history of pollution, the possibility is less remote. The introduction of such elements into the oceans and estuarine areas can be considered indirect, that is, from contaminated rivers, streams, and runoff; or they can be direct, that is, when metallic pollutants are pumped into estuaries or the sea from the shore, discharged into the water by vessels, or added to the water from aerial fallout. Industrial wastes frequently include copper, zinc, chromium, cadmium, nickel, and lead (Merlini, 1971). Until recent restriction by EPA, they also contained mercury.

Dispersal of mercury in the environment stems primarily from its wide use as a germicide or fungicide; its general use as a slimicide, fungicide, and paint mildew preventer, and its use in

electrical, chemical, and pharmaceutical industries. In addition, mercury can be set free during the heating or burning of ores, soils, and fuels (Merlini, *ibid*).

Heavy metals, due to the fact that they are chemical elements, are non-degradable. Even if precipitated from the water, or absorbed, the process can be reversible and the metals can return to the ionic, or dissolved, form. If they are not redissolved, the precipitate (undissolved particles) settles on the bottom and can be ingested by benthic organisms. Dilution and dispersion help minimize the danger to some of the biota, but filter-feeding organisms have the ability to concentrate materials present only in trace quantities - in particular, copper, zinc, iron, and manganese (Merlini, *ibid.*). In this way, they can be introduced into the food chain, and because they are cumulative in animal tissues, produce toxic effects. Once in the food chain, these metals can cause mortality of marine fauna and flora or can render them unsafe for human consumption.

The most recent environmental statement prepared by this Department contained the following passage:

"We have made an effort to seek information on the contamination of the Louisiana marine and estuarine environments by toxic heavy metals from the literature and from individuals having expertise in this area, but as yet, we have obtained none. We can only note that concentrations of heavy metals in the Gulf sediments, while they might occur, are likely to be confined to river beds and adjacent delta areas close to shore." --(pg. 89, U.S. Dept. Interior, 1972.)

Since that statement was prepared, personnel within the Bureau of Land Management have continued to seek evidence of heavy metal contamination in the northwestern Gulf of Mexico and associated coastal zone. This search has been very unrewarding. The only findings are as follows:

Mercury content: (U.S. Geological Survey, 1970)
Gulf of Mexico--Unconsolidated sediment--70 to 220 parts per billion found in 27 samples. (This was one of the lowest entries in a table of mercury content of rocks, soils and stream sediments and was as low as values for Wilderness and Primitive Area streams in Montana and California, however, the sampling site was not given for the 27 Gulf samples.)

Another study (Holmes, 1972) shows chromium content of sediments taken from the continental shelf within about 150 miles of Galveston, to range from 0 to 150 ppm., of nickel from 20 to 70 ppm., and of lead from 0 to 50 ppm.

(b) Impact on Resources and Their Use

Commercial fishermen might suffer the same impacts as were noted in the discussions on open waters offshore. In addition, a commercially valuable oyster reef might be damaged by dredging and spoils, if operations were extensive. Repopulation would follow immediately, but harvestable oysters would take about two years to mature.

The fabrication and laying operation would be aesthetically unpleasing during its brief (two to three weeks) span.

Previously undiscovered historic and archeological sites and objects could be damaged.

(5) Impact of Fabricating and Laying Pipelines Across Coastal Zone Marshes

(a) Impact on the Natural Environment

Recent studies by Gagliano and

Van Beek (1970) have revealed that 16.5 square miles of coastal

wetlands are lost each year in Louisiana due to subsidence, erosion, and construction. Chapman (1967) has stated that due to dredging and filling over the past 20 years in Texas, about 700 miles of Federal navigation channels have altered 13,000 acres of shallow bay bottoms and destroyed 7,000 acres of brackish marsh by deepening, and that spoil from these channels has filled 55,000 acres of shallow bays and covered 23,000 acres of brackish marsh.

Most coastal wetlands damage and loss is now due to navigation and drainage canal construction and land reclamation projects. In the past, much damage was also caused by dredging of rig access canals for exploration and production in the marshes, but this period of history in the oil industry is drawing to a close. None of the published studies of coastal wetlands loss contains high enough resolution to allow an estimate to be made of wetlands loss attributable to the oil industry (Gagliano, Light, and Becker, 1971).

Canal construction contributes directly to wetlands loss by physically removing the substrate falling within the dimensions of the canal. Indirectly, they promote wetlands loss by fostering freshwater drainage and increased tidal circulation, resulting in erosion. The environment is altered by replacing

a marsh community with an aquatic one and, in many instances, substantially increasing the salinity in the vicinity of the canal.

Two types of canals are generally used in pipeline laying through the marsh. Where the soil is unstructured and consists largely of organic material, especially in floating mats, a channel must be dredged with dimensions large enough to allow a pipeline-laying barge to be towed through it. These canals are left open. If they run parallel to the natural drainage direction, they can promote erosion by pirating freshwater drainage from the many small, sinuous marsh streams and bayous, and by permitting accelerated tidal exchange. If they are oriented perpendicularly to the natural drainage direction, their spill banks can cause a damming and ponding of water on the upstream side.

Where the marsh soil is more firm, a dragline mounted on a marsh buggy-type carriage may be used to cut a small ditch, just large enough for floating in the pipeline itself, thus eliminating the necessity for dredging a full-scale canal (Gagliano, 1971). This operation produces less spoil and the resulting ditch is usually backfilled. Gagliano notes that the marsh buggy tracts often cause pronounced changes

in the marsh surface, particularly in areas of floating marsh, where the floating vegetation mat may be permanently damaged. Gagliano also notes, relative to the open canal, that "dikes or water control structures are usually required on both state-owned and privately owned land on all canals at points above and below the intersection of any existing waterway. Such structures are designed to minimize saltwater intrusion and circulation change. There is usually a contract clause requiring perpetual maintenance of these structures by the petroleum or pipeline companies." This arrangement serves to mitigate the impact on hydrology but results in increased vehicular activity in the area for construction and maintenance.

Historically, most wetlands loss credited to the oil industry was due to access canals dredged to site drilling rigs and was not directly related to offshore oil and gas development. No rig access canals will be cut as a result of OCS operations.

As was stated earlier, at the most, three new pipelines would be constructed if this proposed sale is held. At this time, it is not known if any of them would cross a marsh before connecting with existing facilities.

(b) Impact on Resources and Their Uses

Perhaps a previously undiscovered historical or archeological site or object could be harmed by pipeline laying in the marsh. It is difficult to perceive any other direct impact on resources. Indirect impacts could occur if pipeline activity alters a nursery area for a commercial species of fish or shellfish and the population decreased as a result.

C. Production Phase

1. Production Well Drilling

As soon as all construction is complete, production well drilling commences. It is accomplished in the same manner as exploratory well drilling. Generally, there are fewer wells drilled from platforms in shallow waters. In deep waters near the continental shelf edge, the number of production wells per platform can exceed thirty. An average for all offshore platforms is three wells. This average, of course, includes many older platforms with only one or two wells remaining in production. The potential impacts are the same as for exploratory well drilling, except for one possible addition.

After drilling of all wells is completed on a given platform, the drilling mud, or part of it may be discarded into the ocean. Drilling mud may be classified as:

a. Debris and Pollutants Other than Oil

- (1) Sinking or Diffusing Non-metallic and Non-degradable Materials (e.g., drilling muds, mud additives, along with cement, drill cuttings and sand)

Drilling muds, are not extraneous to actual production operations but for purposes of this discussion can be classified as debris.

The muds usually used on the OCS down to the surface casing setting point consist of sea water and gel (bentonite clay).

This is light weight mud with few, if any, chemicals. Below the surface casing, the mud system is generally changed to a sea water lignosulfonate system.

Some chemicals generally used are aluminum stearate for foaming control, bentonite for gelling mud, barite for weighting material, carboxymethylcellulose for fluid loss, lignosulfonate for a thinner and for fluid loss, bicarbonate of soda for cement contamination and caustic soda for pH control. Caustic soda is the only one of these chemicals considered toxic in concentrated form. The muds that are used offshore have pH's in the range of 7.5 to 10. The caustic (sodium hydroxide) used to keep the pH high will, in the presence of sea water and within certain pH ranges, precipitate out as calcium hydroxide, magnesium hydroxide, and barium hydroxide, and will sink immediately to the bottom because of its specific gravity.

Water base mud with a weight less than 15 pounds per gallon (ppg.) may be treated with a centrifuge to recover the barites and the mud may be dispersed into the ocean.

Mud systems below 12-13 ppg. would, under certain conditions, be uneconomical to haul to shore for re-sale or storage. The volumes to be disposed of vary from 250 to 2,000 barrels,

depending on the rig's mud tank capacity and the size and depth of the hole. However, volumes of these essentially neutral muds are not dumped after the drilling of each well, especially in the case of platform drilling where it is retained for use in drilling other wells at that location.

Moreover, it may not be dumped at all because mud companies are very interested in obtaining this liquid mud for re-sale and bid for it when they have the opportunity and available mud boats to pick it up. Several companies have been organized specifically for the purpose of picking up, storing and re-selling drilling muds. Drillers also do not dump heavy, highly-treated mud systems that may be used for certain drilling conditions because such mud systems are expensive.

In any case, regardless of conditions, all oil base mud is shipped to shore and stored in tanks for future use.

(a) Impact of Drilling Muds on the Natural Environment

Apparently, there is no adverse impact caused by the controlled dumping of muds as discussed above, at least into neritic waters. The possibility does exist that through an accident, such as the damage or destruction of a plat-

form, or the rupturing of a mud barge, that oil based muds could be released into the sea or navigable bay waters.

As the result of a spill of drilling mud (diesel oil base), Cabrera (1971) performed laboratory aquarium experiments designed to determine the survival of oysters exposed to whole drilling muds and several component parts. He found that whole drilling muds reduced the survival of oysters significantly in concentrations of over 200 parts per million. These results are barely applicable because the drilling mud used in Cabrera's experiments contained tannic acid, a vigorous protein coagulant, and tannic acid is not used in OCS muds. In addition, aquarium mortalities should not be equated to ecosystem damage. Nevertheless, the general toxicity of drilling muds was shown.

Falk (1972, Unpublished report), in studying toxicity of drilling fluids that could contaminate the Mackenzie River estuary (Northwest Territories, Canada), utilized bioassays which included caged fish in the disposal pits which contained diluted drilling fluids along with laboratory aquarium tests. He observed rapid death of fish (within 4 hours) in relatively concentrated drilling fluids and less rapid but total mortality in more

dilute fluids (within 50 hours). He concluded that: (a) "Petrochemical drilling fluids are toxic to fish at very low concentrations", (b) "The toxicity of drilling fluids vary (sic) depending on the nature and amount of chemicals used." (c) "The toxicity of drilling fluids is probably due to a combination of the physical and chemical properties" (pH, resultant turbidity, toxic compounds). The specific applicability of this study is also questionable because the ingredients of the muds are not listed in Falk's report. However, the general harmful nature of drilling muds is shown.

(b) Impact on Resources and Their Use

No impact should result on resources through normal drilling activity. A spill of oil based muds, and those containing toxic compounds, could have an indirect impact by harming commercial fish and shellfish populations in a local area.

2. Production Well Workover, Platform Maintenance and Repair Work

Accidents caused by carelessness or error in judgments during routine rework, maintenance and repair have resulted in at least two large spills of oil, along with destruction of

platforms, the loss of a work vessel and several human lives. On May 28, 1970, renovation and repair work were being carried out on a platform in Galveston Block 189-L, offshore Texas. The platform had been shut-down and workmen were sandblasting, painting, torch-cutting, and welding. When welding was attempted on a line leading to a storage tank containing 2,000 bbl. of crude oil, a series of explosions occurred, resulting in the death of five workmen and injuries to six. Burning oil spilled onto a nearby service boat, nearly destroying it, and about 100 bbl. also reached shore, polluting Galveston beaches. (National Transportation Safety Board, 1970).

The Bay Marchand Fire (Shell Fire and Spill) of 1970-71 was ignited as a result of carelessness. The plastic coating on the tubing of one well sloughed off and plugged the tube. During cleaning operations, workmen neglected to close well control valves for a brief period while the well was left unattended. The well blew off and the fire ignited. Ten of the other 21 wells on the platform were damaged by the initial explosion and also blewout and caught fire. Four workmen died immediately. After five months, the last of the blowing wells was capped (Nelson, 1972). An undetermined

amount of petroleum was consumed by the fire and 53,000 bbl. spilled into the sea. Such an accident on a gas producing platform might still result in loss of life and equipment but most likely would not cause a significant impact on the environment.

(a) Impact of Production Accidents on the Natural Environment

The impact would include the same features as described for exploratory well blowouts, including air and oil pollution.

(b) Impact on Resources and Their Use

The impacts on resources would be the same as described for exploratory well blowouts.

3. Production Operations

a. Pipeline Ruptures and Leaks

If a ruptured pipeline was carrying natural gas, there would be no significant impact on the environment. However, if it was carrying oil, a significant amount of pollution could result. The largest oil spill in the history of oil production in the Gulf of Mexico occurred in October, 1967, when a ship, dragging its anchor in a storm, broke a pipeline which lost over 160,000 bbl. of oil into the water. This type of accident is less likely to happen now, because all pipelines are buried when laid in water depths of less than 200 feet, and because older, unburied pipelines would probably have sunk into the sediments by now. Nevertheless, it is a possibility. Also, shrimp trawling in over 200 feet of water could still result in damage to a pipeline (unburied) in water over 200 feet deep.

A pipeline break could also occur as a result of tectonic activity. Fisher et. al., (1972) have noted that withdrawal of vast quantities of ground water in Houston-Bay City-Texas City triangle has resulted in significant land subsidence. Concomittent with the subsidence has been the activation of numerous faults within the withdrawal area. The area of maximum subsidence and active faulting includes extensive areas within Galveston Bay.

Fisher et. al., caution that: "The subsidence area contains the highest concentration of oil, gas, petroleum products, and chemical pipeline systems in the world. An extensive system of production pipelines also connects several bay oil fields with bay-side facilities. The combination of dense pipeline systems and subsidence and faulting indicates the need for careful monitoring of the pipelines to avoid a rupture within or along Galveston Bay."

(1) Impact on the Natural Environment

The impact of an oil spill is essentially the same, regardless of source, and has been described in the section on exploration and construction. The only difference is in the degree or extent of impact. The same principles would apply in a bay as were described for shallow neritic waters: physical smothering and chemical toxicity.

A leaking pipeline could also release oil into the marsh. The effects would be the same as were described for an oil spill from a wild well.

(2) Impact on Resources and Their Use

Impact would be the same as discussed for exploratory well blowouts.

b. Pollution by Toxic Materials Other Than Oil

(1) Produced Oil-Field Waters

The waters associated with oil and gas pools are called oil-field waters. 1/ The lower edge or boundary of most oil and gas pools is marked by an oil-water or gas-water contact or boundary plane. In some pools, water comes with the oil in early stages of production, whereas in others, appreciable water never comes up with the oil.

Oil-field waters may be classified into three groups:

(i) Meteoric water has fallen as rain and has filled up the permeable shallow rocks and percolated through them along structural planes, fractures, and permeable layers. This type

1/ Discussion is largely from: Levorsen, 1958.

of water contains dissolved oxygen and carbon dioxide. The oxygen may react with sulphides to produce sulphates, and the carbon dioxide may react to produce carbonates and biocarbonates. This type of water remains relatively fresh to mildly brackish.

(ii) Connate water is originally sea water in which marine sediments were deposited. It is doubtful whether oil-field waters of this type actually remain as the original water in place because most reservoir waters are quite different in chemical composition from sea water. They are thought to have circulated and have probably been completely replaced since the sediments were deposited. Most oil-field waters are brines, characterized by an abundance of chlorides, mostly as sodium chloride, and have concentrations of dissolved solids several times greater than that of modern sea water.

(iii) Mixed waters are characterized by both a chloride and sulphate-bicarbonate content, suggesting a multiple origin.

The total amount of mineral matter commonly found dissolved in oil-field waters ranges from a few hundred parts per million (ppm) in nearly fresh water to approximately 300,000 ppm in a heavy brine. One of the highest concentrations recorded was

624,798 ppm; or 64.3 percent, from a field in Michigan (Case, 1945, as cited by Levorsen op. cit.).

The following table shows the content of three representative brines: (1) high solids, (2) average solids, and (3) low solids. The average total dissolved solids of 76 samples from south Louisiana and the outer continental shelf was found to be 112,513 milligrams per liter (mg/l). The average of available samples from Federal offshore areas was found to be 141,473 mg/l with a high of 270,400 mg/l and low of 61,552 mg/l. Note that they commonly contain varying amounts of iron, calcium, magnesium, sodium, bicarbonates, sulphate, and chloride, with sodium and chloride being the most abundant ions.

Total waste water production from OCS operations offshore Louisiana is about 420,000 barrels per day; 240,000 barrels per day are transported to shore for treatment and release, and the remaining 180,000 barrels per day are treated and discharged near the platforms. No figures are available for offshore Texas. Small amounts of oil are entrained in this waste water, making it necessary to treat and remove as much of this oil as possible prior to releasing the waste water. This subject is discussed separately in a later section.

Chemical Content of Representative Offshore Brines 1/

Component	High Solids		Average Solids		Low Solids	
	Mg/1	%	Mg/1	%	Mg/1	%
Iron	153	0.057	15	0.011	139	0.226
Calcium	17,000	6.287	4,675	3.294	772	1.254
Magnesium	2,090	0.773	1,030	0.726	152	0.247
Sodium	84,500	31.250	49,120	34.612	22,651	36.800
Bicarbonate	37	0.014	100	0.070	933	1.516
Sulphate	120	0.044	0		188	0.305
Chloride	166,500	61.575	86,975	61.287	36,717	59.652
Total Solids	270,400	100%	141,915	100%	61,552	100%

1/ From U.S. Geological Survey, Oil and Gas Supervisor, Gulf Coast Region, New Orleans, Louisiana.

Water produced at platform installations which is not to be piped ashore is processed to remove entrained oil and then is normally aerated and therefore is low or void of dissolved oxygen. This condition might lead to a low oxygen level in the immediate outfall near the sump. Because of water currents, wind currents and wave action, the conditions would not be concentrated around the platform but would tail away and diminish as water mixing and wave action brings the oxygen content to that of the surrounding water. Due to the relative amounts involved, the higher dissolved mineral concentrations would be diluted, rapidly.

Oil-field water resulting from OCS operations which is piped to onshore terminal points in Texas falls under the authority of the Texas Railroad Commission. It is usually collected in impervious collecting pits, where it is skimmed to remove hydrocarbons. The Railroad Commission does not ordinarily allow it to be released into dry creeks, flowing creeks, or rivers, but will allow it to be released into the offshore and adjacent estuarine zones.

(a) Impact of Oil-Field Waters on the Natural Environment

(i) Offshore Areas, Larger River-Influenced and Tide-Influenced Bays

No apparent harm is caused in these areas by the release of oil-field waters. Existing evidence

indicates water currents move the effluent away from the outfall and dilute it with the large volumes of water in these areas. Mackin (1971) studies the effect of oil-field brine effluents in several Texas estuaries including Galveston Trinity Bay, Lavaca-Matagorda Bay, and Baffin Bay, and associated streams.

His data, in general, show an adverse effect on taxon diversity and population size in the immediate vicinity of the outfall (300-500 feet). Beyond that, there is sometimes a zone of stimulated growth in the next few hundred feet, after which, numbers return to "normal". Plankton tows and artificial substrate colonization rates indicated that the brine had no adverse effect on reproduction. Oysters suspended on the order of 1/2 mile from the outfall in Trinity Bay underwent "growth as good as any ever reported for the Gulf of Mexico".

In contrast, Simmons (1970) found that during years of low rainfall, the influence of brine discharges may adversely affect 45 percent or more of Capano Bay, Texas.

(ii) Small Lakes, Tidal Bayous, and Streams

Mackin (op. cit.) has found that within 2,500 feet of a brine outfall, species number and

diversity "has every evidence of being normal" in a small tidal bayou (Clear Creek-Cow Bayou). He also found that brine effluent had an effect on bottom fauna at least 3/4 of the distance across a small brackish coastal lake.

A study of the effects of oil-field brine discharge in the Chiltipin Creek, Texas area (Simmons, op. cit.) led to the following conclusions: "Salinity above 25-30 ppt appears to be very unfavorable to marine life when that salinity is influenced by brine inflow. Natural salinities of this magnitude are not detrimental." Simmons found that between periods of rainfall, oil-field brine caused salinity in the creek to rise to unfavorable levels and drive out or kill marine life. His study revealed that heavy rainfall ameliorated the effects of the brine and during these periods, marine life moved into the creek from the bay (Capano Bay) below.

(2) Toxic Chemicals Used in Production Operations

The only chemicals of importance which could be included in this category are polychlorinated biphenyl liquids. Any polychlorinated biphenyls (PCB's) escaping into the environment would constitute a serious hazard if they contaminated food stuffs. Both oil and gas producing

wells utilize heat-exchangers to break down oil/water emulsions and to readily remove entrained water after the product leaves the well-head. Many heat-exchangers in the past have contained PCB's as a heat-exchanger fluid and they are still used in some cases. When the hazardous nature of PCB's became evident, some chemical companies and its distributors discontinued the manufacture and sale of this material. They have developed, and are marketing, new heat-exchanger circulants which are relatively non-toxic, longer-lived, have better heat transfer properties, and are less expensive than PCB's.

It has been estimated by industry that about 95% of all older-type heater-exchangers utilizing PCB's have been replaced by the oil companies. Thus, the chances of new introduction of PCB's as heat-exchange fluids on this proposed sale are low. Although, before all PCB fluids now utilized by the industry are replaced, there is some possibility of those fluids being transferred into new treating facilities.

Where units have used PCB's as a circulant in the past and might still be in operation today, the quantities involved vary from about 800 to 5000 gallons per unit.

Even in units where PCB's might occur, the units are self-contained and PCB's could escape to the environment like oil, only by accident. Every unit contains a drip pan and sump for catching any possibility of spillage. As with oil spills it would have to be a major accident or fire that would cause release to the environment.

Accident or fire could release PCB's or oil into the environment but under very remote circumstances for this sale. Ocean release would add directly to sea contamination in the amount released. Under the circumstances of low probability, nearly phased-out PCB use, and the use of spill prevention curbing and catch-pans provided, the possibility of impact is considered slight.

4. Chronic, Low-Level Oil Spillage

a. Impact on the Natural Environment

Although casual observation evokes the premise that OCS oil and gas production operations are seemingly "clean", statistical evidence exists 1/ that small spills of fractions of a barrel to 50 barrels occur on the order of a thousand times per year in the Gulf of Mexico.

1/ See later section on possibility of occurrence of impact-producing events.

The problem of determining potential impact from chronic, low-level spillage is difficult. Virtually none of the reports of scientific investigations on oil spillage, which we were able to obtain, addressed the effects of low-level, continuous spillage in offshore waters. A few scientists have offered cautious speculation. A more pessimistic view is taken by Blumer (1969) who has stated:

"...we are rather ignorant about long-term and low level effects of crude oil pollution. I fear that these may well be far more serious and long lasting than the more obvious short term effects."

Blumer (ibid) then points out that hydrocarbons are taken up into the food chain, and through the process of 'biological magnification', can become concentrated in marine species used by man for food. He states: "One consequence will be the incorporation into food of materials which produce an undesirable flavor. A far more serious effect is the potential accumulation in human food of long term poisons derived from crude oil, for instance of carcinogenic compounds." Blumer also cautions that low level pollution may

damage the marine ecology by masking natural chemical sex attractants, interfering with chemical food sensing and enemy repulsion. He states: "There is good reason to believe that pollution interferes with these processes in two ways: by blocking the taste receptors and by mimicking for natural stimuli;..."

A somewhat less pessimistic view is taken by St. Amant (1972). In offshore areas, where chronic spills could result from leaking vessels and plumbing, and discharge of oil-contaminated, produced brine waters, St. Amant views the problem as follows: "Chronic pollution from offshore production sites represents an unknown factor. Daily drips and loss of small amounts of oil or other chemicals overboard do not appear to generate ecological problems because of the relative immensity of the water volumes. Whether such sublethal pollution will eventually accumulate and cause environmental degradation is yet to be determined. Because of this unknown factor, significant effort should be made to prevent low-level pollution."

A still less pessimistic view is taken by Oppenheimer. 1/
He notes that hydrocarbons have been a part of the natural environment since life began. Also, that "... except for the commercial concentrations of oil in our geosphere, no recognizable concentration of specific molecules have persisted in the aquatic environment other than tar balls, as microorganisms are ubiquitous in their role in mineralization or recycling of the hydrocarbons in natural environments." Oppenheimer continues: "There is a priori evidence that hydrocarbons may in some areas be significant as a nutrient source for living organisms. It may not be surprising when one looks at the pathway of hydrocarbon degradation. A first step of degradation is the formation of fatty acids which is a good source of food for marine organisms. It is interesting to note that the fish catch in the oil producing areas of Louisiana has increased materially during the past 30 years. Fishing effort in the Gulf remained somewhat constant over the last 10 years with 10,000 small boats and 3,500 vessels operating...Logic tells us that fish must

1/ Oral and written testimony given by Dr. Carl Oppenheimer of Univ. Texas Marine Station at the OCS Public Hearing on a proposed oil and gas lease sale offshore Louisiana. August 23, 1972. New Orleans, Louisiana.

be present if they are being caught. This fish catch increase is in an area where nearly 3 billion barrels of oil have been produced over the last 40 years. I find that total fishcatch, as it represents the top of the food chain, can be a good indicator for the state of the environment." In his summary, Oppenheimer notes "...there (is) no conclusive evidence of long-term adverse oil effects on the living populations,..."

Because of the wide variation in scientific opinion on this and other subjects, and because of the general lack of concrete evidence for damage or lack of damage, the Department has authorized a special research program through the Bureau of Land Management. 1/

1/ The Bureau of Land Management has established a project to evaluate, on a continuing basis, the effects of oil spills from offshore oil and gas exploration and production in the Gulf of Mexico. This project will consist of a team of 15 people to be comprised of marine biologists, oceanographers, pipeline engineers and support personnel working out of New Orleans. They will initiate studies and compile data concerning the short- and long-term impact of oil spills on marine biota as well as the environmental effects of pipeline construction resulting from offshore operations. Although this project was put into full operation in the fall of 1972, it will be some time before initial study results and data will become available for dissemination. This project will also be available for possible expansion of its activities into new areas where offshore leasing may be proposed.

D. Termination of Oil and Gas Operations

According to industry estimates, with proper placement of wells and sufficient pipeline capacity, a gas reservoir could be profitably drained in as little as ten years. In contrast, some oil reservoirs have been produced for over twenty years in offshore areas. When the reservoir is depleted to a level where it cannot be profitably produced, operations are terminated. The production platform is removed and the well heads are severed and removed to fifteen feet below the mudline. All that remains is the pipeline system. In all probability, major trunklines could be used for future oil and gas production from adjacent areas, but smaller spurlines would be abandoned in place. There is no known impact on either the natural environment or resources and their use from terminating oil and gas operations.

E. Frequency of Occurrence of Impact-Producing Events and Significant Accidents Related to Offshore Oil and Gas Operations in the Gulf of Mexico

In the preceding discussion of impacts, no mention was made of how often they have occurred in the past, and by extension, how often they may be expected in the future, especially as a result of this proposed sale. Some impacts are the unavoidable result of routine operations and the probability of their occurrence, should this proposed sale be held, is 1.00, or 100%. These operations include:

- release of cleaned drilling muds and cuttings
- release of produced oil-field brines
- jetting pipelines into open ocean and bay sediments
- dredging pipeline canals in marsh areas
- placement of temporary and permanent boats, barges, platforms, and pipelines in conflict with commercial fishery trawling operations and ship navigation
- placement of structures, etc., and pipeline burial cuts and canals where they will degrade the scenic values of the area.

Other impact-producing events must be viewed as accidental and at least theoretically avoidable. It has been possible

to gather data and derive statistical frequencies for some of these events, and present it below.

1. Natural Gas Leaks Associated with Blowouts

Information furnished by the Geological Survey for the period 1956-1971 lists 30 gas leaks associated with well blowouts during OCS oil and gas operations in the Gulf of Mexico. Ten of these incidents involved fires and four were associated with oil or condensate spills. The duration of the blowouts ranged from two hours to over seven months. Several incidents included the loss of life and equipment but none of the leaking gas resulted in environmental damage. There are no estimates available of the amount of gas lost.

2. Major Oil Spills

Data supplied by the Geological Survey 1/ for the period 1964-1971 indicates a total of 36 significant oil spill incidents connected with Federal OCS oil and gas operations in the Gulf of Mexico involving 50 bbl. or more of oil and condensate. The estimated total volume of oil spilled during this period as a result of these incidents is slightly less than 280,000 bbl.

1/ Geological Survey "OCS Statistics - 1953-1971".

The largest single recorded spill incident as previously mentioned was a pipeline rupture in the West Delta Area in 1967 caused by a ship dragging its anchor and resulting in a spill of 160,639 bbl. of oil.

During this time period, almost 2 billion bbl. of oil and condensate were produced in the Gulf of Mexico offshore Texas and Louisiana. Therefore, the amount of recorded spills during this period represents 0.014% of all oil and condensate produced in the area during the same period.

Assuming that estimated production of oil on tracts proposed for offering in this sale will range from 5,000-11,000 bbl./day by the sixth year of leasing this would mean that by 1979-80 oil production from these proposed tracts could range from 1.825 million to 4.015 million bbl./year. If 0.014% of past production is taken as the true spillage rate, then this would mean 260 to 560 bbl./yr. of oil produced from tracts included in the proposed lease sale, could be spilled. But all spills are accidents, and the volumes resulting cannot be predetermined nor, as the following indicates, can any trends be identified by looking at past data concerning volume or number of incidents.

<u>Year</u>	<u>Number of Incidents</u>	<u>Total Production/bbl.</u>	<u>Total Spill/bbl.</u>	<u>% of Production Spilled</u>
1964	5	122,500,126	14,928	0.0122
1965	1	144,968,615	500	0.0003
1966	0	188,714,070	0	0
1967	2	221,861,614	160,704	0.072
1968	2	266,936,001	6,085	0.0023
1969	8	302,919,143	10,924	0.0036
1970	7	335,658,540	84,323	0.0251
1971	20	387,445,398	1,473	0.0004

The number of incidents show an increase beginning in 1969. This is the same year that Gulf of Mexico OCS operating orders became effective requiring the recording of all spills, reporting of all spills greater than 15 bbl., daily inspection of manned facilities and regular inspections of unmanned facilities. There has been a total of 10 oil spills of 1,000 bbl. or more in over 18 years of OCS leasing. Six out of the ten major oil spills occurred during the period from 1964-1968 and four during the period following implementation of the OCS operating orders of 1969-1971.

3. Minor Spills

During the first nine months of 1972, 839 minor spills of less than 50 bbl. involving 836 barrels (42 gals/barrel) of oil were recorded by the Geological Survey from OCS

oil and gas operations in the Gulf of Mexico. The majority of these spills (682) involved one barrel of oil or less totalling 170 bbl. One hundred and fifty-two of the recorded spills involved 1 to 15 barrels totalling 525 barrels. Only five spills exceeded 15 barrels of oil (141 barrels). An additional 499 oil slicks from unidentified sources were sighted in the first nine months of 1972 and are not positively related to offshore drilling. There is evidence of natural oil seepage in the Gulf of Mexico, first recorded in 1906, long before oil development activities were initiated, and seepage still persists in oil prone areas. It is possible that these natural seeps could be the source of some oil slicks classified as being from an "unidentified source".

4. Collisions Resulting from Conflict Between Ship Navigation and Offshore Structures

During the period July 1, 1962 through June 30, 1971, the Coast Guard recorded 24 incidents of collisions between vessels and fixed platforms. Total damages were estimated to be about \$0.4 million to vessels and \$3.4 million to the structures. Only 4 injuries and no deaths were reported. Of these, only 8 accidents involved vessels of over 1,000 gross tons; however these 8 accidents accounted for \$87 thousand of vessel damage (only 4 vessels reported damage) and over \$3,200 thousand to platforms and no injuries

or deaths reported. Five of these accidents occurred at night (three within two hours of midnight) and two during daylight. All of the eight major accidents occurred outside established shipping fairways and anchorage areas and only three were less than five miles from these established areas. At least five of the accidents involved foreign flag vessels. The worst of these eight accidents occurred in 1967 when a 11600 ton foreign flag cargo vessel collided with a platform in Ship Shoal Area block 214 at 1:30 a.m. during heavy rain, poor visibility, 45 knot wind and 15-20 foot seas. The vessel escaped with damages estimated at \$12,000 but damages to the platform were of the order of \$1.1 million or 1/3 of the total damages to platforms in all eight accidents.

The remaining 16 incidents of collision between vessels (less than 1000 gross tons) and platforms caused more damage (\$290 thousand) to the vessels than to the platforms (\$100 thousand). Causes were assigned as 2-weather, 8-vessels and 6-platforms; the platforms causes were further defined as 3-equipment failures, 2-insufficient or improper lighting and 1-improper maintenance.

5. Accidental Deaths on Oil Industry Structures and Vessels

Information supplied by the U.S. Coast Guard reveals that a total of 94 individuals were killed as a result of accidents involving construction, supply, and drilling vessels, workboats, mobile drill rigs, and artificial islands in the Gulf of Mexico and adjacent navigable inland waters during the period 1964-1971. Of these 94 deaths, approximately 60 occurred in waters approximately equal to the Federal OCS area. The following table, provided by the Coast Guard shows these casualties by source and year. These figures do not include deaths resulting from accidents in which no vessel or rig damage occurred (i.e., persons falling or knocked overboard, crushed by drilling equipment, etc.). Partial figures for fiscal year 1967 through 1971 indicate that approximately 25 persons were killed in oil operations in the Gulf of Mexico (both inland and international waters) with no casualty to the vessel being involved.

Based on the years 1967-71, the death rate due to offshore oil operations and involving vessel damage in international waters was 34 and in inland waters was 27. Distributing the 25 deaths not involving vessel damage according to the 34:27

ratio, an additional 14 deaths may be added to the total for international waters, giving a grand total of 48 deaths for the five year period. Based upon this information, at least ten deaths per year may be expected in the Gulf of Mexico as a result of offshore oil industry activity in OCS waters.

Deaths Resulting From a Vessel Casualty

Inland Waters Gulf of Mexico

Gulf of Mexico

Fiscal Years

	64	65	66	67	68	69	70	71		64	65	66	67	68	69	70	71
Mobile Drill Rigs and Artificial Islands	No	info	-	7	-	12	-	-		No	info	-	-	2	1	7	14
Oil Industry Supply Vessels and Workboats	-	-	-	-	-	-	3	2		1	-	2	-	-	-	-	4
Oil Industry Construction and Drilling Vessels	4	1	2	1	-	2	-	-		22	1	-	1	-	-	2	3
Sub Total	4	1	2	8	-	14	3	2		23	1	2	1	2	1	9	21
Total 94																	

F. A Matrix Analysis of Some Possible Adverse Impacts on the Environment and Related Uses

In this section, a matrix system is introduced for the purpose of identifying and analyzing on a tract-by-tract basis those factors resulting from the proposed sale which could impact on the environment and which lend themselves to such an analysis. The matrix itself is simply a device used for displaying the interrelationships of some of the impact-producing factors (on the horizontal axis of each matrix) with coastal activities and resources which could sustain an impact (on the vertical axis of each matrix) and for assigning values to these interrelationships.

1. Purpose - The purpose is to analyze possible impacts of the proposed OCS lease sale on the environment using a matrix analytical technique in an attempt to provide the decision-maker and reviewer with an array of factors which must be considered in order to form value judgments concerning the importance of these impacts to the environment.

2. Significant Resource Factors - The matrix analysis examines major factors which could sustain negative impacts as a result of the development of the tracts included in the proposed lease

sale. Significant resource factors appear on the vertical axis of each matrix and for purposes of this analysis have been identified and placed into two groups as follows:

a. Natural Resource System

Refuges/wildlife management areas 1/

Estuary/marsh/nursery areas

Biota seaward of estuary/nursery areas

Beaches

b. Coastal Activities/Multiple Uses

Shipping

Recreation (boating, swimming, water oriented activities other than sport fishing)

Commercial fishing

Sport fishing

3. Impact-Producing Factors - The matrix includes two major categories of factors which can impact on significant resources (i.e., natural resource systems, and coastal activities) as a result of the development of proposed OCS oil and gas leases. The Impact-Producing Factors appear on the horizontal axis of each matrix and have been identified as follows:
-

1/ Includes parks, sanctuaries, historical landmarks, etc.

a. Structures (e.g., platforms, fixed structures and artificial islands)

b. Oil spills

Other impact-producing factors such as debris and pipelines cannot be analyzed on a tract-by-tract basis and therefore are not included in this matrix section. However, these factors are discussed on the basis of the entire sale elsewhere in the statement.

4. Analytic Procedures - Each impact-producing factor is analyzed on the basis of (A) its potential magnitude and persistence which we have termed its importance, and (B) its proximity to high value resources or coastal activities/multiple uses. A series of scales has been devised for the purpose of assigning a range of values consisting of importance and proximity to each impact-producing factor. These scales together with definitions and discussions are presented below:

(A) IMPORTANCE

a. Structures:

Under some conditions, structures have an adverse effect on commercial fishing activities. Depending on currents and under-

water obstacles an offshore structure can remove areas of trawling and purse seining waters. Heavy concentrations of platforms can make trawling and purse seining difficult.

Oil and gas platforms pose a hazard to commercial fishing and boating in general. Directional drilling from outside shipping lanes, however, can be used to develop tracts lying partially in shipping lanes.

An estimate of the importance of the impact of structures on the environment consists of two factors: 1.) quantity--in this case it is estimated that all tracts 5,000 acres or more in size will average 3 structures per tract, even though many tracts may never be developed, and 2.) time--all structures will remain on site for an average period of 15 to 20 years.

b. Oil Spills:

The same two factors for estimating the importance of oil spills on the environment are as follows: 1.) quantity--our analysis is based on all spills of 1,000 bbl. or more; and 2.) time--based on past experience the oil itself may remain in contact with, or a hazard to, the environment for a period of 1 to 90 days.

A scale indicating the importance structures and oil spills pose to significant resources on coastal activities/multiple uses follows:

Scale of Importance

- | | |
|-----|---|
| 100 | - Oil spills: complete destruction of a resource within the immediate area of a spill, impossible to remedy or control; structure: permanent obstruction and disruption of coastal activities/multiple uses |
| 80 | - Oil spills: very hazardous to life and extremely difficult to remedy; structures: very inconvenient interference with coastal activities/multiple uses |
| 60 | - Oil spills: hazardous to plant and animal life and costly to remedy or control; structures: inconvenient interference with coastal activities/multiple uses |
| 40 | - Oil spills: unsightly and potentially hazardous to plant and animal life but relatively easy to remedy or control; structures: some minor inconvenience to coastal activities/multiple uses |
| 20 | - Oil spills: unsightly; structures: slight inconvenience |
| 0 | - No adverse effect |

(B) PROXIMITY

Each tract is assigned a proximity number, based on its distance from shore or high-value resources as follows:

Proximity Scale (Oil Spills)

1.0 - Tract is within 5.0 miles of shore or significant resource.

0.9	"	"	"	5.1-6.0	"	"	"	"	"
0.8	"	"	"	6.1-7.0	"	"	"	"	"
0.7	"	"	"	7.1-9.0	"	"	"	"	"
0.6	"	"	"	9.1-11.0	"	"	"	"	"
0.5	"	"	"	11.1-14.0	"	"	"	"	"
0.4	"	"	"	14.1-17.0	"	"	"	"	"
0.3	"	"	"	17.1-21.0	"	"	"	"	"
0.2	"	"	"	21.1-25.0	"	"	"	"	"
0.1	"	"	"	25.1-30.0	"	"	"	"	"
0.0	"	"	"	30.1- up	"	"	"	"	"

The proximity of production tracts to areas such as refuges, nursery areas, marshlands, heavy commercial fishing areas, etc. takes into account the response time necessary to implement adequate contingency measures to stop or retard oil from reaching such areas.

This analysis assumes that an oil spill of 1000 bbl. or more has

occurred and that with average shoreward ocean current velocities of 0.5 knots, oil spills from a tract 5.0 nautical miles from shore or high value resource could deposit oil on that area within 10 hours; for a tract 10.0 nautical miles from shore or high value resource oil could be deposited within 20 hours, etc. The oil industry has developed a contingency plan that will enable oil containment and clean-up equipment to be brought into use within 12 hours of notification that a spill has occurred.

The proximity scale with regard to structures takes into account their potential impact on shipping and is different than that for oil spills, as shown below:

Proximity Scale (Structures)*

- 1.0 - Tract partially within shipping lane, anchorage area, natural resource system
- 0.8 - Tract within one mile of shipping lane, anchorage area, natural resource system, or activity area
- 0.6 - Tract within 1.1-3 miles of shipping lane, anchorage area, natural resource system, or activity area
- 0.4 - Tract within 3.1-6 miles of shipping lane, anchorage area, natural resource system, or activity area 1/
- 0.2 - Tract within 6.1-10 miles of shipping lane, anchorage area, natural resource system, or activity area
- 0.0 - Tract beyond 10 miles of shipping lane, anchorage area, natural resource system, or activity area

*Measurements taken from the edge of a tract to the nearest edge of a shipping lane, anchorage area, natural resource system or activity area.

1/ Each proposed tract not located in an intensive commercial fishing area has been assigned a value of 0.4. This value has been assigned to reflect the fact that commercial fishing activities occur throughout the Gulf and therefore, all platforms placed on the continental shelf will be in proximity to some kind of commercial fishing activity regardless of water depth or distance from shore. See section II.E.2.b. for a description of the distribution of commercial fishing activity.

(C) RELATIVE ENVIRONMENTAL IMPACT FACTOR

A relative environmental impact factor is a product of Importance, and Proximity, and is expressed both for structures, F (St) and oil spills, F (O.S.). The equation for obtaining this factor can be expressed simply as $I \times P = F$ (St. or O.S.).

The higher the relative environmental impact factor, the higher the potential for environmental damage. Tracts with overall high environmental indices will be singled out for additional consideration in accordance with the scale below. It is very important for the decision-maker or reviewer to keep in mind the possible synergistic and/or accumulative effects resulting from a tract having one or more categories within a high index range.

This scale of relative environmental impact factors is proposed for determining the potential damage a tract might pose to a significant resource or activity.

Relative Environmental Impact Scale

Greater than or equal to
50

Relative environmental impact factor in this range indicates that the tract should be carefully scrutinized. Depending upon the significance and character of the resource that may be affected, possibilities in the decision include:

- (1) Withdraw the entire tract from the proposed offering.
- (2) Offer only a portion of the tract.
- (3) Offer the tract with special stipulations included in the lease to reduce the potential for damage or hazard.
- (4) Offer the tract because of mitigating circumstances with or without special stipulations.

Greater than zero but
less than 50

Relative environmental impact factor in this range indicates that the tract could be developed safely within existing standard practices and operating regulations without significant damage to the resource involved. Additional special stipulations in the lease would not normally be necessary.

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

GALVESTON

BLOCK 190 (E 1/2)

Tract Data:

Statute Miles from Shore 13
Water Depth - Feet 50
Est. Type of Production OIL

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100	0.0	0
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.5	50
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40	1.0	40
Beaches	40	0.0	0	80	0.5	40
Coastal Activities/Multiple Use Shipping	80	0.4	32	20	1.0	20
Recreation (Outdoor)	40	0.0	0	80	0.5	40
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Lease Area and Block

GALVESTON

BLOCK 211 (N 1/2)

Tract Data:

Statute Miles from Shore 14
Water Depth - Feet 55
Est. Type of Production OIL

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100	0.1	10
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.4	40
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40	1.0	40
Beaches	40	0.0	0	80	0.4	32
Coastal Activities/Multiple Use Shipping	80	0.4	32	20	1.0	20
Recreation (Outdoor)	40	0.0	0	80	0.4	32
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Legend: IM=Importance F(ST)=Impact Factor - Structures
PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

GALVESTON**BLOCK 212 (N^{1/2})**

Tract Data:

Statute Miles from Shore 12Water Depth - Feet 55Est. Type of Production OIL

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100	0.1	10
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.5	50
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40	1.0	40
Beaches	40	0.0	0	80	0.5	40
Coastal Activities/Multiple Use Shipping	80	0.4	32	20	0.9	18
Recreation (Outdoor)	40	0.0	0	80	0.5	40
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Lease Area and Block

GALVESTON**BLOCK 325**

Tract Data:

Statute Miles from Shore 28Water Depth - Feet 75Est. Type of Production OIL & GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100	0.1	10
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.1	10
Biota Seaward of Estuary/Nursery Areas	0	0.1	0	40	0.1	40
Beaches	40	0.0	0	80	0.1	8
Coastal Activities/Multiple Use Shipping	80	0.4	32	20	0.9	18
Recreation (Outdoor)	40	0.0	0	80	0.1	8
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 266 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

GALVESTON
BLOCK 326

Tract Data:

Statute Miles from Shore 27Water Depth - Feet 75Est. Type of Production OIL & GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100	0.1	10
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.1	10
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40	1.0	40
Beaches	40	0.0	0	80	0.1	8
Coastal Activities/Multiple Use Shipping	80	0.4	32	20	1.0	20
Recreation (Outdoor)	40	0.0	0	80	0.1	8
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Lease Area and Block

GALVESTON

Tract Data:

Statute Miles from Shore 20Water Depth - Feet 80

Est. Type of Production

BLOCK 381**OIL & GAS**

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100	0.2	20
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.3	30
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40	1.0	40
Beaches	40	0.0	0	80	0.3	24
Coastal Activities/Multiple Use Shipping	80	0.8	64	20	1.0	20
Recreation (Outdoor)	40	0.0	0	80	0.3	24
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Legend: IM=Importance F(ST)=Impact Factor - Structures 267
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

GALVESTON**BLOCK 382**

Tract Data:

Statute Miles from Shore **23**Water Depth - Feet **90**Est. Type of Production **OIL & GAS**

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100	0.2	20
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.2	20
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40	1.0	40
Beaches	40	0.0	0	80	0.2	16
Coastal Activities/Multiple Use Shipping	80	0.6	48	20	1.0	20
Recreation (Outdoor)	40	0.0	0	80	0.2	16
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Lease Area and Block

GALVESTON**BLOCK 392 (N½)**

Tract Data:

Statute Miles from Shore **24**Water Depth - Feet **90**Est. Type of Production **OIL & GAS**

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100	0.1	10
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.2	20
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40	1.0	40
Beaches	40	0.0	0	80	0.2	16
Coastal Activities/Multiple Use Shipping	80	0.4	32	20	1.0	20
Recreation (Outdoor)	40	0.0	0	80	0.2	16
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Legend: IM=Importance F(ST)=Impact Factor - Structures
 268 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

GALVESTON
BLOCK 393 (N 1/2)

Tract Data:

Statute Miles from Shore 22
Water Depth - Feet 90
Est. Type of Production OIL & GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100	0.1	10
Estuary/Marsh/Nursery Areas	20	0.0	0	100	0.2	20
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40	1.0	40
Beaches	40	0.0	0	80	0.2	16
Coastal Activities/Multiple Use Shipping	80	0.4	32	20	1.0	20
Recreation (Outdoor)	40	0.0	0	80	0.2	16
Commercial Fishing	80	1.0	80	80	1.0	80
Sport Fishing	0	1.0	0	80	1.0	80

Lease Area and Block

GALVESTON
SOUTH ADDITION

Tract Data:

Statute Miles from Shore 55
Water Depth - Feet 155
Est. Type of Production GAS**BLOCK A123**

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.2	16	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 269
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

Galveston
South Addition
block A124

Tract Data:

Statute Miles from Shore 57

Water Depth - Feet 160

Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block

Galveston
South Addition
block A130

Tract Data:

Statute Miles from Shore 65

Water Depth - Feet 155

Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
270 PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A131

Tract Data:
Statute Miles from Shore 63
Water Depth - Feet 160
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.4	32	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
block A133

Tract Data:
Statute Miles from Shore 59
Water Depth - Feet 165
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.2	16	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 271
PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

Galveston
South Addition
block A134

Tract Data:

Statute Miles from Shore 57
Water Depth - Feet 165
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.2	16	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block

Galveston
South Addition
block A135

Tract Data:

Statute Miles from Shore 55
Water Depth - Feet 170
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
272 PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A152

Tract Data:
Statute Miles from Shore 58
Water Depth - Feet 170
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
block A153

Tract Data:
Statute Miles from Shore 60
Water Depth - Feet 170
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 273
PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A154

Tract Data:
Statute Miles from Shore 62
Water Depth - Feet 170
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
block A156

Tract Data:
Statute Miles from Shore 65
Water Depth - Feet 180
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.4	32	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
274 PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
Block A157

Tract Data:
Statute Miles from Shore 67
Water Depth - Feet 185
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.4	32	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
Block A163

Tract Data:
Statute Miles from Shore 63
Water Depth - Feet 170
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 275
PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A164

Tract Data:
Statute Miles from Shore 62
Water Depth - Feet 160
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
block A165

Tract Data:
Statute Miles from Shore 60
Water Depth - Feet 175
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
276 PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A166

Tract Data:
Statute Miles from Shore 59
Water Depth - Feet 180
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		}
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
block A181

Tract Data:
Statute Miles from Shore 61
Water Depth - Feet 205
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		}
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A182

Tract Data:
 Statute Miles from Shore 63
 Water Depth - Feet 190
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
block A183

Tract Data:
 Statute Miles from Shore 64
 Water Depth - Feet 205
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A184

Tract Data:
Statute Miles from Shore 66
Water Depth - Feet 205
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
block A198

Tract Data:
Statute Miles from Shore 61
Water Depth - Feet 240
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A199

Tract Data:
Statute Miles from Shore 59
Water Depth - Feet 230
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
Galveston
South Addition
block A208

Tract Data:
Statute Miles from Shore 62
Water Depth - Feet 265
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
PR=Proximity F(OS)=Impact Factor - Oil Spills
280 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
Galveston
South Addition
block A209

Tract Data:
Statute Miles from Shore 63
Water Depth - Feet 270
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
block 92

Tract Data:
Statute Miles from Shore 17
Water Depth - Feet 45
Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.3	6	100		NCG
Estuary/Marsh/Nursery Areas	20	0.4	8	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.4	8	80		
Coastal Activities/Multiple Use Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.4	16	80		
Commercial Fishing	80	1.0	80	80		
Sport Fishing	0	1.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 281
PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
block 110

Tract Data:
 Statute Miles from Shore 18
 Water Depth - Feet 45
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	1.0	80	80		
Sport Fishing	0	1.0	0	80		

Lease Area and Block
High Island
block 111

Tract Data:
 Statute Miles from Shore 20
 Water Depth - Feet 45
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	1.0	80	80		
Sport Fishing	0	1.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 282 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
block 141 (W 1/2)

Tract Data:
 Statute Miles from Shore 17
 Water Depth - Feet 50
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	1.0	80	80		}
Sport Fishing	0	1.0	0	80		

Lease Area and Block
High Island
block 142

Tract Data:
 Statute Miles from Shore 16
 Water Depth - Feet 50
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	1.0	80	80		}
Sport Fishing	0	1.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

High Island

block 154 (N 1/2)

Tract Data:

Statute Miles from Shore 18

Water Depth - Feet 50

Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	1.0	80	80		
Sport Fishing	0	1.0	0	80		

Lease Area and Block

High Island

block 200

Tract Data:

Statute Miles from Shore 32

Water Depth - Feet 30

Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.4	32	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	1.0	80	80		
Sport Fishing	0	1.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 284 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A 442

Tract Data:
 Statute Miles from Shore 80
 Water Depth - Feet 170
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A 446

Tract Data:
 Statute Miles from Shore 78
 Water Depth - Feet 165
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A447

Tract Data:
 Statute Miles from Shore 76
 Water Depth - Feet 160
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A448

Tract Data:
 Statute Miles from Shore 74
 Water Depth - Feet 160
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 286 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A457

Tract Data:
 Statute Miles from Shore 65
 Water Depth - Feet 145
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		}
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A463

Tract Data:
 Statute Miles from Shore 77
 Water Depth - Feet 165
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		}
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills 287
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A 464

Tract Data:
 Statute Miles from Shore 78
 Water Depth - Feet 170
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A 465

Tract Data:
 Statute Miles from Shore 80
 Water Depth - Feet 175
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 288 NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A474

Tract Data:
 Statute Miles from Shore 79
 Water Depth - Feet 170
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A475

Tract Data:
 Statute Miles from Shore 78
 Water Depth - Feet 165
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.2	16	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A480

Tract Data:
 Statute Miles from Shore 67
 Water Depth - Feet 155
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		}
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A481

Tract Data:
 Statute Miles from Shore 65
 Water Depth - Feet 150
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.8	64	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		}
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance - F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A482

Tract Data:
 Statute Miles from Shore 67
 Water Depth - Feet 160
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	0.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A483

Tract Data:
 Statute Miles from Shore 69
 Water Depth - Feet 165
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.8	64	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 291
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A488

Tract Data:
 Statute Miles from Shore 79
 Water Depth - Feet 175
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.2	16	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A489

Tract Data:
 Statute Miles from Shore 81
 Water Depth - Feet 175
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 292 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A495

Tract Data:
 Statute Miles from Shore 93
 Water Depth - Feet 220
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A496

Tract Data:
 Statute Miles from Shore 91
 Water Depth - Feet 220
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 293
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A502

Tract Data:
 Statute Miles from Shore 80
 Water Depth - Feet 180
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.4	32	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A513

Tract Data:
 Statute Miles from Shore 81
 Water Depth - Feet 190
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.4	32	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A518

Tract Data:
 Statute Miles from Shore 92
 Water Depth - Feet 210
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A519

Tract Data:
 Statute Miles from Shore 93
 Water Depth - Feet 215
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 295
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A520

Tract Data:
 Statute Miles from Shore 95
 Water Depth - Feet 225
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A521

Tract Data:
 Statute Miles from Shore 97
 Water Depth - Feet 235
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 296 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A532

Tract Data:
 Statute Miles from Shore 75
 Water Depth - Feet 185
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		{
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		{
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A533

Tract Data:
 Statute Miles from Shore 74
 Water Depth - Feet 185
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		{
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		{
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

High Island
South Addition
block A534

Tract Data:

Statute Miles from Shore 76

Water Depth - Feet 180

Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.4	32	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block

High Island
South Addition
block A535

Tract Data:

Statute Miles from Shore 78

Water Depth - Feet 195

Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
PR=Proximity F(OS)=Impact Factor - Oil Spills
NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
Block A555

Tract Data:
 Statute Miles from Shore 86
 Water Depth - Feet 234
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
Block A556

Tract Data:
 Statute Miles from Shore 84
 Water Depth - Feet 245
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A558

Tract Data:
 Statute Miles from Shore 80
 Water Depth - Feet 210
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A559

Tract Data:
 Statute Miles from Shore 78
 Water Depth - Feet 210
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.4	32	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 300 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
 block *A563*

Tract Data:
 Statute Miles from Shore 86
 Water Depth - Feet 295
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	1.0	80	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
 block *A564*

Tract Data:
 Statute Miles from Shore 88
 Water Depth - Feet 305
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 301
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A570

Tract Data:
 Statute Miles from Shore 102
 Water Depth - Feet 280
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A571

Tract Data:
 Statute Miles from Shore 104
 Water Depth - Feet 280
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 302 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
South Addition
block A572

Tract Data:
 Statute Miles from Shore 105
 Water Depth - Feet 295
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
~~West Flower Garden Bank~~ Estuary/Marsh/Nursery Areas	20	0.4	8	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
South Addition
block A573

Tract Data:
 Statute Miles from Shore 107
 Water Depth - Feet 330
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas ~~West Flower Garden Bank~~	20	0.4	8	100		
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.2	16	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 303
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block

High Island
East Addition
block 46

Tract Data:

Statute Miles from Shore 17Water Depth - Feet 20Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.6	48	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	1.0	80	80		
Sport Fishing	0	1.0	0	80		

Lease Area and Block

High Island
East Addition - South Extension
block A262

Tract Data:

Statute Miles from Shore 85Water Depth - Feet 150Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.2	16	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 304 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
East Addition - South Extension
Block A263

Tract Data:
 Statute Miles from Shore 84
 Water Depth - Feet 150
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		{
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
East Addition - South Extension
Block A272

Tract Data:
 Statute Miles from Shore 88
 Water Depth - Feet 160
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		{
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
East Addition - South Extension
block A273

Tract Data:
 Statute Miles from Shore 88
 Water Depth - Feet 160
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
East Addition - South Extension
block A274

Tract Data:
 Statute Miles from Shore 89
 Water Depth - Feet 160
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 306 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
East Addition - South Extension
block A275

Tract Data:
 Statute Miles from Shore 89
 Water Depth - Feet 165
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.2	16	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
East Addition - South Extension
block A276

Tract Data:
 Statute Miles from Shore 92
 Water Depth - Feet 180
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills 307
 NCG=Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
East Addition - South Extension
block A277

Tract Data:
 Statute Miles from Shore 92
 Water Depth - Feet 175
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
East Addition - South Extension
block A278

Tract Data:
 Statute Miles from Shore 91
 Water Depth - Feet 180
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 308 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
East Addition - South Extension
block A279

Tract Data:
 Statute Miles from Shore 90
 Water Depth - Feet 175
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
East Addition - South Extension
block A283

Tract Data:
 Statute Miles from Shore 83
 Water Depth - Feet 170
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use						
Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 309
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
East Addition - South Extension
block A298

Tract Data:
 Statute Miles from Shore 94
 Water Depth - Feet 195
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
East Addition - South Extension
block A299

Tract Data:
 Statute Miles from Shore 92
 Water Depth - Feet 195
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 310 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

Lease Area and Block
High Island
East Addition - South Extension
Block A304

Tract Data:
 Statute Miles from Shore 94
 Water Depth - Feet 210
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Areas	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Lease Area and Block
High Island
East Addition - South Extension
Block A305

Tract Data:
 Statute Miles from Shore 96
 Water Depth - Feet 205
 Est. Type of Production GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	Structures			Oil Spills (1000+ bbl)		
	IM	PR	F(ST)	IM	PR	F(OS)
Natural Resource Systems: Refuges/Management Area	20	0.0	0	100		NCG
Estuary/Marsh/Nursery Areas	20	0.0	0	100		}
Biota Seaward of Estuary/Nursery Areas	0	1.0	0	40		
Beaches	40	0.0	0	80		
Coastal Activities/Multiple Use Shipping	80	0.0	0	20		
Recreation (Outdoor)	40	0.0	0	80		
Commercial Fishing	80	0.4	32	80		
Sport Fishing	0	0.0	0	80		

Legend: IM=Importance F(ST)=Impact Factor - Structures 311
 PR=Proximity F(OS)=Impact Factor - Oil Spills
 NCG-Not Computed for Gas only Blocks

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A312

TRACT DATA:

STATUTE MILES FROM SHORE 104

WATER DEPTH - FEET 210

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSEY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSEY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A313

TRACT DATA:

STATUTE MILES FROM SHORE 104

WATER DEPTH - FEET 210

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSEY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSEY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A314

TRACT DATA:

STATUTE MILES FROM SHORE 102

WATER DEPTH - FEET 210

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A317

TRACT DATA:

STATUTE MILES FROM SHORE 96

WATER DEPTH - FEET 215

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A322

TRACT DATA:

STATUTE MILES FROM SHORE 98

WATER DEPTH - FEET 235

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A323

TRACT DATA:

STATUTE MILES FROM SHORE 100

WATER DEPTH - FEET 225

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
 314 PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
 NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A324

TRACT DATA:

STATUTE MILES FROM SHORE 102

WATER DEPTH - FEET 220

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIODIVERSITY OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A325

TRACT DATA:

STATUTE MILES FROM SHORE 104

WATER DEPTH - FEET 215

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIODIVERSITY OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A326

TRACT DATA:

STATUTE MILES FROM SHORE 106

WATER DEPTH - FEET 210

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A327

TRACT DATA:

STATUTE MILES FROM SHORE 107

WATER DEPTH - FEET 220

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A328

TRACT DATA:

STATUTE MILES FROM SHORE 108

WATER DEPTH - FEET 222

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A329

TRACT DATA:

STATUTE MILES FROM SHORE 108

WATER DEPTH - FEET 185

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
 PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
 NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A330

TRACT DATA:

STATUTE MILES FROM SHORE 111

WATER DEPTH - FEET 264

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank						
ESTUARY/MARSH/NURSERY AREAS	20	0.2	4	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A331

TRACT DATA:

STATUTE MILES FROM SHORE 111

WATER DEPTH - FEET 264

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank						
ESTUARY/MARSH/NURSERY AREAS	20	0.2	4	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A332

TRACT DATA:

STATUTE MILES FROM SHORE 110

WATER DEPTH - FEET 230

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank ESTUARY/MARSH/NURSERIES AREAS	20	0.2	4	100		
BIOFA SEAWARD OF ESTUARY/ NURSERIES AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A333

TRACT DATA:

STATUTE MILES FROM SHORE 109

WATER DEPTH - FEET 220

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank ESTUARY/MARSH/NURSERIES AREAS	20	0.2	4	100		
BIOFA SEAWARD OF ESTUARY/ NURSERIES AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition-South Extension
block A334

TRACT DATA:

STATUTE MILES FROM SHORE 106

WATER DEPTH - FEET 220

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank ESTUARY/MARSH/NURSERY AREAS	20	0.2	4	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition-South Extension
block A336

TRACT DATA:

STATUTE MILES FROM SHORE 102

WATER DEPTH - FEET 235

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition-South Extension
block A337

TRACT DATA:

STATUTE MILES FROM SHORE 100

WATER DEPTH - FEET 235

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition-South Extension
block A340

TRACT DATA:

STATUTE MILES FROM SHORE 99

WATER DEPTH - FEET 192

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS 321

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A341

TRACT DATA:

STATUTE MILES FROM SHORE 101

WATER DEPTH - FEET 245

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A350

TRACT DATA:

STATUTE MILES FROM SHORE 117

WATER DEPTH - FEET 282

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank ESTUARY/MARSH/NURSERY AREAS	20	0.2	4	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A351

TRACT DATA:

STATUTE MILES FROM SHORE 116

WATER DEPTH - FEET 282

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
~~East Flower Garden Bank~~ ESTUARY/MARSH/NURSERY AREAS	20	0.4	8	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A358

TRACT DATA:

STATUTE MILES FROM SHORE 104

WATER DEPTH - FEET 240

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
~~West Flower Garden Bank~~ ESTUARY/MARSH/NURSERY AREAS	20	0.2	4	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
 PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
 NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A359

TRACT DATA:

STATUTE MILES FROM SHORE 102

WATER DEPTH - FEET 200

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
West Flower Garden Bank						
ESTUARY/MARSH/NURSERY AREAS	20	0.2	4	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A360

TRACT DATA:

STATUTE MILES FROM SHORE 104

WATER DEPTH - FEET 270

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
West Flower Garden Bank						
ESTUARY/MARSH/NURSERY AREAS	20	0.4	8	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A361

TRACT DATA:

STATUTE MILES FROM SHORE 106

WATER DEPTH - FEET 275

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
West Flower Garden Bank ESTUARY/MARSH/NURSERY AREAS	20	0.4	8	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition - South Extension
block A368

TRACT DATA:

STATUTE MILES FROM SHORE 119

WATER DEPTH - FEET 335

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank ESTUARY/MARSH/NURSERY AREAS	20	0.6	12	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS 325

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
High Island
East Addition-South Extension
Block A369

TRACT DATA:

STATUTE MILES FROM SHORE 120

WATER DEPTH - FEET 360

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank						
ESTUARY/MARSH/NURSERY AREAS	20	0.4	8	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	0.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
High Island
East Addition-South Extension
Block A370

TRACT DATA:

STATUTE MILES FROM SHORE 120

WATER DEPTH - FEET 390

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
East Flower Garden Bank						
ESTUARY/MARSH/NURSERY AREAS	20	0.2	4	100		
BIOFA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
West Cameron
South Addition
block 528

TRACT DATA:

STATUTE MILES FROM SHORE 90

WATER DEPTH - FEET 175

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	1.0	80	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
West Cameron
South Addition
block 586

TRACT DATA:

STATUTE MILES FROM SHORE 110

WATER DEPTH - FEET 235

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
 PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
 NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
West Cameron
South Addition
block 595

TRACT DATA:
STATUTE MILES FROM SHORE 113
WATER DEPTH - FEET 250
EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK
East Cameron
South Addition
block 269

TRACT DATA:
STATUTE MILES FROM SHORE 78
WATER DEPTH - FEET 160
EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000 + BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.0	0	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES
PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS
NCG = NOT COMPUTED FOR GAS ONLY BLOCKS

ANALYSIS OF POSSIBLE ADVERSE ENVIRONMENTAL IMPACT

LEASE AREA AND BLOCK
East Cameron
South Addition
block 335

TRACT DATA:

STATUTE MILES FROM SHORE 104

WATER DEPTH - FEET 270

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20	0.0	0	100		NCG
ESTUARY/MARSH/NURSERY AREAS	20	0.0	0	100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0	1.0	0	40		
BEACHES	40	0.0	0	80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80	0.4	32	20		
RECREATION (OUTDOOR)	40	0.0	0	80		
COMMERCIAL FISHING	80	0.4	32	80		
SPORT FISHING	0	0.0	0	80		

LEASE AREA AND BLOCK

TRACT DATA:

STATUTE MILES FROM SHORE

WATER DEPTH - FEET

EST. TYPE OF PRODUCTION GAS

SIGNIFICANT RESOURCE FACTORS	IMPACT FACTORS					
	STRUCTURES			OIL SPILLS (1000+ BBL)		
	IM	PR	F(ST)	IM	PR	F(OS)
<u>NATURAL RESOURCE SYSTEMS:</u>						
REFUGES/MANAGEMENT AREAS	20			100		NCG
ESTUARY/MARSH/NURSERY AREAS	20			100		
BIOTA SEAWARD OF ESTUARY/ NURSERY AREAS	0			40		
BEACHES	40			80		
<u>COASTAL ACTIVITIES/MULTIPLE USES:</u>						
SHIPPING	80			20		
RECREATION (OUTDOOR)	40			80		
COMMERCIAL FISHING	80			80		
SPORT FISHING	0			80		

LEGEND: IM = IMPORTANCE F(ST) = IMPACT FACTOR - STRUCTURES

PR = PROXIMITY F(OS) = IMPACT FACTOR - OIL SPILLS

NCG = NOT COMPUTED FOR GAS ONLY BLOCKS 329

G. Recapitulation of Matrices

1. Refuges/Management Areas -

None of the tracts in this proposed sale reflect an environmental impact factor for oil spills of over 20 in relation to refuges/management areas. Even a massive oil spill resulting from any one of the 9 tracts in this proposed sale estimated to be oil or oil and gas producing would not be expected to impact upon refuges/management areas.

2. Estuary/Marsh/Nursery Areas -

Galveston Area, blocks 190 (E1/2) and 212 (N1/2) show environmental impact factors of 50 for oil spills in relation to estuary/marsh/nursery areas. This is primarily a reflection of their proximity to the above resource areas and the fact that they are estimated to be oil producing tracts. A massive oil spill resulting from these two tracts could impact upon the above resources given special circumstances such as those discussed in the following section (Mitigating Measures).

3. Biota Seaward of Estuary Nursery Areas

The 9 tracts in this proposed sale estimated to produce oil or oil and gas reflect an environmental impact factor of 40 for oil spills in relation to this natural resource category.

Of all the categories identified in the matrix analysis, the adverse impact of an oil spill on biota in open water is the one we know the least about. Although data in this area is sparse, it is discussed in section III. B. 2. c (2) of this statement.

4. Beaches -

All 9 tracts estimated to produce oil in this proposed sale could impact on beaches in the event of a major oil spill. However, there are no tracts in this proposed sale which have an environmental impact factor of over 40 for oil spills in relation to beaches.

5. Shipping -

High Island, blocks 92, 110, 111, 142, and 154 (N1/2); High Island, South Addition, blocks A482, A532, A556 and A563; and West Cameron, South Addition, block 528 each have environmental impact factors of 80 for structures in relation to shipping. This is a reflection of the fact that each of these tracts are partially within shipping lanes or anchorage areas. Development of these tracts would be subject to Federal Regulation as described in section IV. B.

There are also 3 blocks which have an environmental impact factor of 64 for structures in relation to shipping: Galveston, block 381,

and High Island - South Addition, blocks A481 and A483. These tracts are within one mile of established shipping fairways. In addition, there are a total of 34 tracts that range from 1.1 to 10 miles from shipping fairways or anchorage areas (environmental impact factors of 16 to 48). All remaining tracts in this proposed offering are over 10 miles from shipping lanes or anchorage areas.

6. Outdoor Recreation -

There are no tracts in this proposed sale which reflect an environmental impact factor of 50 or more under either structures or oil spills for this category.

7. Commercial Fishing -

The 9 tracts identified for oil or oil and gas production each reflect environmental impact factors of 80 regarding oil spills and structures in relation to commercial fishing. In addition, a total of 8 gas tracts (High Island, blocks 92, 110, 111, 141, 142, 154, and 200; and, High Island - East Addition, block 46) each reflect an environmental impact factor of 80 for structures in relation to commercial fishing.

The above 17 proposed tracts are located within an area identified in section II. E.2. (see especially Figure 24) as

a major commercial fishing zone. Accordingly, these tracts should be carefully scrutinized as part of the decision-making process. A suggested stipulation concerning the development of these tracts has been presented in section IV. B. If adopted, this stipulation would help mitigate the impact resulting from the placement of structures in relation to commercial fishing activities. However, the potential adverse impact on commercial fishing activities and commercial fish species resulting from oil spills can not be mitigated by a special stipulation.

8. Sport Fishing -

Each of the 9 tracts in this proposed sale estimated for oil production show an environmental impact factor of 80 for oil spills in relation to sport fishing. This is a result of the proximity of these tracts to sport fishing areas and a reflection of the fact that the tracts involved are estimated oil producers.

In every case, the environmental impact factor of structures for sport fishing is fixed at a zero. This reflects the fact that offshore structures have a favorable impact on sport fishing activities by concentrating fish around the platforms

and thereby increasing the average catch. Most of the sport fishing from platforms is undertaken within 30 miles from shore, although some sport fishing craft make overnight trips and can venture out much further. Offshore platforms also serve as aids to navigation, a source of assistance in emergencies and havens for small boats in storms. Platforms resulting from blocks leased as a result of this proposed sale could be expected to have a positive and favorable impact on sport fishing and small boat recreationists over a long period of time (at least 20 years).

BIBLIOGRAPHY

- Baker, J. M. 1971. The effects of a single oil spillage. p. 16-20. In. E. B. Cowell (ed.) the ecological effects of oil pollution on littoral communities. Elsevier, London.
- Blumer, M. 1969. Oil pollution of the ocean. p. 5-13. In. D. P. Hoult (ed.) Oil on the sea. Plenum Press. New York.
- Blumer, M. 1971. Scientific aspects of the oil spill problem. Environmental Affairs. 1:54-73.
- Blumer, M., G. Souza, and J. Sass. 1970. Hydrocarbon pollution of edible shellfish by an oil spill. Mar. Biol. 5:195-202.
- Bourne, W. R. P. 1968. Oil pollution and bird populations. p. 99-122. In. The biological effects of oil pollution on littoral communities. Field Studies, Suppl. to Vol. 2.
- Cabrera, J. 1971. Survival of the oyster (Crassostrea virginica) (Gmelin) in the laboratory under the effects of oil drilling fluids spilled in the Laguna de Tamiahua, Mexico. Gulf Res. Rep. 3:197-213.
- Case, L. C. 1945. Exceptional silurian brine near Bay City, Michigan. Bull. Amer. Assoc. Petrol. Geol. 29:567-570.
- Chan, G. 1972. A study of the effects of the San Francisco oil spill on marine organisms. Part I. College of Marin, Kentfield, California. 78 p.
- Chapman, C. 1967. Channelization and spoiling in Gulf coast and south Atlantic estuaries. p. 92-106. In. J. D. Newsom (ed.) Proceedings of the marsh and estuary management symposium. Louisiana State Univ., Baton Rouge.
- Cobb, D. A. 1972. Effects of suspended solids on larval survival of the eastern lobster, Homarus americanus. Eight Ann. Conf. Expos. Mar. Tech. Soc. Washington, D. C. p. 395-402.
- Connel, D. W. 1971. Kerosene-like tainting in Australian mullet. Australian Wine Research Institute. Glen Osmond, S. Australia.

Cronin, L. E. 1970. Summary, conclusions and recommendations. p. 1-6. In. Natural Resources Institute. Gross physical and biological effects of overboard spoil disposal in upper Chesapeake Bay. Special Rep. No. 3. Univ. Maryland.

Ehrhardt, M. 1972. Petroleum hydrocarbons in oysters from Galveston Bay. Envir. Pol. (in press.)

Environment Editorial Staff. 1971. Horizon to horizon Environment 13(2):13-21.

Esso Production Research Company. 1972. Esso deepwater capabilities. Standard Oil Company (New Jersey), New York, New York. 33 p.

Fauchald, K. 1971. The benthic fauna in the Santa Barbara Channel following the January, 1969, oil spill. p. 61-116. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. So. Calif. Los Angeles.

Fisher, W. L., J. H. McGowen, L. F. Brown, and C. G. Groat. 1972. Environmental geologic atlas of the Texas coastal zone--Galveston-Houston area. Bur. Econ. Geol., Univ. Texas. Austin. 91 p.

Gagliano, S. M. 1971. Hydrology and geologic studies of coastal Louisiana--petroleum industry dredging in the Louisiana coastal zone. Coastal Studies Inst., Dept. Mar. Sci., Louisiana State Univ., Baton Rouge. 27 p. (in press.)

Gagliano, S. M., and J. L. van Beek. 1970. Hydrological and geological studies of coastal Louisiana. Vol. I. Geologic and geomorphic aspects of deltaic processes, Mississippi delta system. Coastal Studies Inst., Dept. Mar. Sci., Louisiana St. Univ., Baton Rouge.

Herbert, D. W. and J. C. Merkens. 1961. The effect of suspended mineral solids on the survival of trout. Int. J. Air and Water Poll. 5:46-55. (original publication not seen.)

- Holmes, C. W. 1972. Distribution of selected elements in surficial marine sediments of the northern Gulf of Mexico continental shelf and slope. U.S. Geological Surv. Open File Report.
- Ingle, R. M. 1952. Studies on the effect of dredging operations upon fish and shellfish. Florida Board of Conserv. Div. Oyster Culture. Tech. Ser. No. 5, Tallahassee, Fla. 26 p.
- Levorsen, A. I. 1958. Geology of Petroleum. Freeman. San Francisco. 702 p.
- Luntz, G. R. 1938. Oyster culture with reference to dredging operations in South Carolina. U.S. Engineer Office. Charleston, South Carolina. (original publication not seen.)
- Mackin, J. G. and A. K. Sparks. 1962. A study of the effects on oysters of crude oil loss from a wild well.
- Merlini, M. 1971. Heavy-metal contamination. p. 461-486. In. D. W. Hood. Interscience. New York.
- National Marine Fisheries Service. 1971a. Shrimp landings. Current Fisheries Statistics No. 5407. U.S. Dept. Commerce. Washington, D. C. 18 p.
- National Marine Fisheries Service. 1971b. Shrimp landings, annual summary 1970. Current Fisheries Statistics No. 5722. U.S. Dept. Commerce. Washington, D. C. 18 p.
- National Transportation Safety Board. 1970. Explosions and fire on the Chambers and Kennedy offshore platform, block 189-L and fire on M/V Carryback in Gulf of Mexico. May 28, 1970. U.S. Dept. Transportation, Washington, D. C. 7 p.
- Nelson, R. F. 1972. The Bay Marchand fire. J. Pet. Tech. March, 1972. p. 225-233.
- Nicholson, N. L. and R. L. Cimberg. 1971. The Santa Barbara oils spills of 1969: a post-spill survey of the rocky intertidal. p. 325-400. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. So. Calif. Los Angeles.

- North, W. J., M. Neushul, and K. A. Clendenning. 1964. Successive biological changes observed in a marine cove exposed to a large spillage of mineral oil. Proc. Symp. Pol. Mar. Microorg. Prod. Petrol., Monaco. p. 335-354.
- Oguri, M. and R. Kantor. 1971. Primary productivity in the Santa Barbara Channel. p. 17-48. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. So. Calif. Los Angeles.
- Operation Oil. 1970. Report of the task force - Operation Oil (Clean-up of the Arrow oil spill in Chedabucto Bay) to the Minister of Transport. Atlantic Oceano. Lab. Bedford Inst. Dartmouth, Nova Scotia.
- Porricelli, J. D., V. F. Keith, and R. L. Storch. 1972. Tankers and the ecology. Trans. Soc. Naval Arch. Mar. Eng. 79:169-221.
- Reinhart, P. W. 1970. Oil seepage potentialities of Dos Cuadras oil field, Santa Barbara County, California. Santa Barbara Environmental Quality Advisory Board. 31 p.
- St. Amant. L. S. 1972. The petroleum industry as it affects marine and estuarine ecology. J. Pet. Tech. 24:385-392.
- Sanders, H. L., J. F. Grassle, and G. R. Hampson. 1972. The West Falmouth oil spill. Part I. Biology. Woods Hole Oceanographic Institution Tech. Rep. No. WHOI-72-20. 49 p. (Unpublished Manuscript.)
- Scarratt, D. J. 1971. Incidence of Bunker C in common benthic animals and sediments. Contrib. Oil Pol. Workshop. Nova Scotia Technical College. Halifax. p. 4-12.
- Shelton, R. G. J. 1971. Effects of oil and oil dispersals on the marine environment. Proc. Roy. Soc. Lond. B 177:411-422.
- Simmons, E. G. 1970. The effects of oil-field brine discharges on the ecology of the Chiltipin Creek - Aransas River - Western Copano Bay area. Texas Parks and Wildlife Dept. Unnumbered Report. Austin, Texas.

- Sonu, C. J., S. P. Murray, and W. G. Smith. 1971. Environmental factors controlling the spread of oil. Naval Research Reviews. August 1971. p. 10-19.
- Spears, R. W. 1970. An evaluation of the effects of crude oil from oil field discharge on aquatic organisms in the Chiltipin Creek - Aransas River - Western Copano Bay - Oso Bay area. Railroad Commission of Texas. Austin. 15 p.
- Straughan, D. 1971a. Oil pollution and seabirds. -. 307-312. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. So. Calif. Los Angeles.
- Texas Instruments Inc. 1971. Biological assessment of diesel spill, Anacortes, Washington. Prepared for Environmental Protection Agency (Contract No. 68-01-0017), Washington, D. C.
- Trask, T. 1971. A study of three sandy beaches in the Santa Barbara, California area. p. 159-178. In. D. Straughan (ed.) Biological and oceanographic survey of the Santa Barbara Channel oil spill, 1969-1970. Vol. I. Biology and Bacteriology. Sea Grant Pub. No. 2. Allan Hancock Foundation. Univ. So. Calif. Los Angeles.
- U. S. Department of Interior. 1970. Interim evaluation of environmental impact from the Chevron Company fire and oil spill of coastal Louisiana. A report issued by the Assistant Secretary for Fish, Wildlife and Parks, Washington, D. C. 38 p.
- U. S. Department of Interior. 1972. Final environmental statement, proposed 1972 outer continental shelf oil and gas general lease sale offshore Louisiana. Washington, D. C.
- U. S. Department of Interior. Draft environmental statement for the proposed prototype oil-shale leasing program. Vol. II. Energy Alternatives. September, 1972.
- U. S. Fish and Wildlife Service. 1968. Shrimp landings. Current Fisheries Statistics No. 4775. U. S. Dept. Interior. Washington, D. C. 17 p.

- U. S. Fish and Wildlife Service. 1970. Shrimp landings.
Current Fisheries Statistics No. 5132. U.S. Dept. Interior,
Washington, D. C. 16 p.
- U. S. Geological Survey. 1970. Mercury in the environment.
Geol. Surv. Prof. Paper 713. U.S. Dept. Interior. Washington,
D. C. 67 p.
- Wallen, I. E. 1951. The direct effect of turbidity on fishes.
Bull. Oklahoma Ag. and Mech. 48(2):1-27. (original publica-
tion not seen.)
- Zitko, V. and W. V. Carson. 1970. Project oil chemistry reports.
Fisheries Res. Board of Canada. St. Andrews, New Brunswick.
(Unpublished Report.)
- Gagliano, S. M., P. Light, and R. E. Becker, 1971. Controlled
diversions in the Mississippi delta system: An approach
to environmental management. Supplement to Report No. 8.
Coastal Studies Institute Department Marine Science,
Louisiana State University, Baton Rouge.

IV. MITIGATING MEASURES INCLUDED IN THE PROPOSED ACTION

The Department has developed the following strategy for safe development of the mineral resources of the OCS.

Management of the mineral resources of the OCS will be conducted in such a manner as to cause these resources to make a significant contribution toward supporting the present and future national economy at a rate consistent with maximum possible protection of the environment, orderly and timely development of the resource, and receipt of a fair market value return to the Federal Government.

Reasonably safe development of oil and gas resources on the OCS can be achieved through strict enforcement of lease stipulations and obligations, (detailed in the OCS operating regulations and orders) and must be based on sound operating practices backed by effective contingency actions in the event that pollution occurs as a result of a natural disaster, human error, or equipment failure.

Research and development programs in exploration, production, transportation, containment and clean-up technology, which provide greater safeguards for the environment, are being conducted by the Department of the Interior, other Federal agencies and private industry. As advances are made, OCS operating regulations

and orders will be revised and the new technology applied to existing leases as well as new leases. Revisions of the regulations and formulation of lease stipulations may also result from the review of environmental impact statements by the agencies and the interested public.

The following discussion concerns the mitigatory measures which will influence any possible adverse impacts that could result from this proposed sale. These measures are presented as they relate to oil spills, offshore structures and pipelines as well as other impact-producing activities associated with OCS oil and gas development.

A. Oil Spills

Galveston Area

<u>Block No.</u>	<u>Miles Offshore</u>	<u>Water Depth</u>	<u>Antici. Production</u>
190 (E 1/2)	13	50	Oil
211 (N 1/2)	14	55	Oil
212 (N 1/2)	12	55	Oil and Gas
325	28	75	"
326	27	75	"
381	20	80	"
382	23	90	"
392 (N 1/2)	24	90	"
393 (N 1/2)	22	90	"

The above list includes all of the tracts in this proposed offering which are anticipated to produce oil or, oil and gas. All remaining tracts in this proposed sale are anticipated to be gas producers only. (See Attachment B for complete tract list.)

An oil spill resulting from development of any one of the Galveston Area tracts could reach the Texas shoreline. The Texas bays, estuaries and marshes behind Bolivar Peninsula, Galveston Island, and coastal areas continuing southwestward are protected by a relatively high beach ridge. The only way oil could reach these inland water areas would be through Bolivar Roads (entrance to Galveston Bay) which is less than 1 1/4 nautical miles in width, through San Luis Pass which is less than 1 nautical mile in width or through Rollover Pass which is less than 100 yards wide. Oil spilled from blocks 190, 211, and 212 would have to travel from

14 to 16 miles due north to reach Bolivar Roads and from 28 to 30 miles due west to reach San Luis Pass. The rest of the tracts in the Galveston Area range from 27-32 miles from San Luis Pass and from 39-56 miles from Bolivar Roads. The only other way oil spilled from the proposed Galveston area tracts could reach inland marshes and waterways would be by extremely high tides associated with hurricanes at the time of a massive oil spill. A description of hurricanes is given in section II. B. 6.a. A hurricane tide could breach the high beachridge and propel oil into bays, estuaries and marshes. The dispersion, dissolution, evaporation, emulsion and oxidation from precipitation, wind and wave action that would act on spilled oil during a hurricane, combined with the distance the oil would have to travel (over 12 miles at the nearest point) to pass over the beach ridge would tend to mitigate the impact.

None of Galveston area tracts are closer than approximately 30 miles from any wildlife refuge. The Anahuac National Wildlife Refuge is protected from the sea by Bolivar Peninsula and the Brazoria National Wildlife Refuge is protected by the Galveston, Mud, Moody, and Folletts Islands. For oil to reach these areas it would have to first pass over the peninsula and islands.

On the basis of the above circumstances and conditions the possibility of an oil spill from this proposed sale actually impacting on marshes, bays, estuaries, inland waterways and wildlife refuges is considered remote.

The major impact area of a spill resulting from this sale, other than the offshore-open water area, would be on the coastal and island beaches.

Only 3 tracts in this proposed sale (Galveston area blocks 190 E 1/2, 211 N 1/2, and 212 N 1/2) are within 15 miles from shore. Under Gulf of Mexico wind, current and wave conditions it is unlikely that an oil spill from these tracts would hold together long enough to deposit massive quantities of oil on the shore.

However, slicks broken off from the main plume, or sheens and rainbows of spilled oil could reach the shore area and be deposited on the beaches.

Various regulations, lease requirements and contingency plans that also serve to mitigate the occurrence of oil spills and their adverse effects that would apply to this proposed sale are presented below:

1. Regulations

Regulations governing OCS oil and gas lease operations in the Gulf of Mexico are contained in Title 30, Code of Federal Regulations and OCS Orders Nos. 1-4, 6, 7, dated August 28, 1969, No. 5, dated June 5, 1972, Nos. 8-9, dated October 20, 1970, No. 11, dated April 5, 1972 and No. 12, dated August 13, 1971.

Leasing regulations are contained in Title 43, Code of Federal Regulations. The regulations established procedures and requirements to be followed in all stages of lease operations: exploration and development, drilling, production, transportation (pipeline construction and operation) and abandonment.

A general description of operating requirements under the existing regulations follows:

a. Plans: Operating plans must be submitted by the operators and approved by the Geological Survey (GS) before each stage of operations is initiated (exploration, development, abandonment). Approval of all operations must be obtained prior to their commencement.

b. Operator Inspection and Testing: The operator is required to inspect all aspects of the safety systems at specific intervals, e.g., daily pollution inspection on manned facilities, "frequent" inspection on unmanned facilities, monthly test of check valves. Detailed records of inspections and tests are required.

c. Reports: The operator is required to report all spills or leakage of oil to GS without delay. He is also required to notify GS of any unusual condition, problem or malfunction within 24 hours. 1/

d. Safety Devices: Required safety devices include sub-surface safety devices, high-low pressure shut-in controls, high liquid level shut-in controls, pressure relief valves, automatic fail-close valves at the well head, automatic fire fighting systems, automatic gas detector and alarm systems, and other safety devices on production equipment; high-low pressure sensing devices and automatic shut-in valves on pipelines; and blowout preventers, related well control equipment, and mud system monitoring equipment on drilling wells.

e. Waste Disposal: The lessee is prohibited from disposing into the ocean any oil (except that oil in produced waste water must average no more than 50 ppm) 2/, untreated waste material or other materials which may be harmful to aquatic life or wildlife. Any drilling mud which may contain toxic substance must

1/ 30 CFR 250.45

2/ OCS Order No. 8 (2.A.(5), Gulf of Mexico.

be neutralized before it can be disposed of in the ocean. Drill cuttings and sand must be processed, and oil removed, before they can be disposed of in the ocean.

f. Site Clearance: When an installation is no longer needed for development of the lease, the well is plugged with cement and all casings and piling must be severed and removed to at least 15 feet below the ocean floor and the location must be dragged to clear the site of any obstruction.

g. Debris: Regulations and OCS Orders prohibit the disposal of debris into the Gulf of Mexico. Solid waste must be either incinerated or transported to shore for disposal.

h. Contingency Plans and Equipment: The operator is required to have an approved plan for controlling and removing pollution which provides for

- (1) Standby pollution control equipment, including containment booms, skimming apparatus, and approved chemical dispersants immediately available to the operator at a land based location.
- (2) Regular inspection and maintenance of such equipment.

The Oil and Hazardous Substances Pollution Contingency Plan, Gulf Coast Region, is operative and has recently been revised and updated to agree with the National Plan 1/. In addition, the Coast Guard is establishing the Gulf Coast Team of the National Strike Force (NSF) at the NASA Mississippi Test Facility, Bay St. Louis, Mississippi for the purpose of responding to oil spills in the Gulf of Mexico. The National Strike Force has been established in accordance with the Federal Water Pollution Control Act and the National Oil and Hazardous Substances Contingency Plan.

The Gulf Coast Team is fully operative at this time and presently consists of 7 men with plans to increase to a total of 13 men in the near future. This team is capable of responding to incidents within 4 hours of notification by the appropriate District Commander.

2. Inspection

Evidence of compliance with the regulations and lease requirements is obtained through surveillance of the operations under the lease and enforcement of specific requirements. The inspection system

1/ See also IV.A.4.b. of this statement and discussion of the National Oil and Hazardous Substances Pollution Contingency Plan.

of the Geological Survey includes: (1) review and approval of plans before each operating stage is initiated, (2) close review and follow-up as necessary, by GS inspectors, of all reports required of the operator by the regulations and orders, (3) on-site inspection and (4) aerial monitoring through the use of helicopters (operators are also required to inform each other of oil spills or other irregularities which they observe).

a. Operator reports: A comprehensive reporting system covering all oil spills and any unusual conditions (for example: reporting and investigation of a persistent oil slick from an unknown source such as a sunken ship or natural oil seep) is required by the orders and is a key factor in monitoring operations. Operators are also required to maintain records for GS inspection of required periodic tests of safety equipment. Compliance with reporting requirements can be assured only by periodic on-the-site inspection and aerial monitoring.

b. On-site Inspection: During the course of drilling, all operations are inspected at least one time. Leases in certain areas or in a particular development stage may require more inspections to assure the achievement of safety objectives. GS is continuing the systematic inspection program and a more stringent enforcement policy. This has resulted in increased

operator compliance along with greater coverage of production operations and better documentation of inspection results.

A program of intensive inspections is used on OCS leases. For example, periodically all available inspectors may devote a week to a special inspection, whereupon production platforms and drilling wells are inspected on a random basis; inspections during other periods are conducted on a regular basis with emphasis on operations believed to require special attention.

The GS inspector force in the Gulf of Mexico has increased from 7 technicians and 5 engineers as of July 1, 1969 to 30 technicians and 5 engineers as of September 1, 1972. During the period January 1, 1972 to November 1, 1972, these technicians spent 2,978 inspection days or 28,169 man-hours, and engineers 319 inspection days or 2,463 man-hours in the field. Detailed inspections were conducted on 1,051 major producing platforms in the Gulf of Mexico from January through November, 1972.

Also during this time period 691 inspections ^{of} single wells or satellites were made by boat. Approximately fifty percent of these inspections were unannounced. Included in these inspections were 10,714 well completions. Also, during this period, 1,054 inspections of drilling rigs were conducted. As of October 31, 1972, there were 9,149 completions capable of producing oil and

gas on OCS lands offshore Louisiana and Texas 1/. Approximately 70 drilling rigs are operating in Gulf of Mexico OCS waters at this time.

c. Aerial Monitoring: "Fly-overs" of the OCS operating areas are programmed on a seven day per week basis by GS inspectors. Any indications of oil pollution or other non-compliance will be followed immediately by an on-site inspection.

During the period January 1 through December 31, 1971, 1,276 pollution surveillance flights were made. The six helicopters chartered by the Geological Survey for use of the inspecting personnel flew a total of 4,854 hours.

3. Enforcement

The enforcement policy is intended to: (1) reduce the frequency of non-compliance with lease requirements which may lead to loss of life, loss of property, or damage to the environment; and (2) maintain a uniform enforcement policy to be applied to all operations affecting OCS lands in the Gulf of Mexico. When, in the course of an inspection, a requirement pertaining to the prevention of oil pollution or any other safety hazard is found to be in non-compliance, the operation will be shut-in until it is brought into compliance. After a shut-in, the operation can only be resumed by authorization

of the GS; in all cases, this requires reinspection or a waiver of the inspection requirement. Minor incidents of non-compliance may require only a warning that corrections be made within a week. The operation will be shut-in if the required corrections are not made.

Additional penalties for non-compliance are specified in P.L. 83-212, Outer Continental Shelf Lands Act, Sec. 5(a)(2).

"Any person who knowingly and willfully violates any rule or regulation prescribed by the Secretary for the prevention of waste, the conservation of the natural resources, or the protection of correlative rights shall be deemed guilty of a misdemeanor and punishable by a fine of not more than \$2,000 or by imprisonment, and each day of violation shall be deemed to be a separate offense." Also Sec. 5(b)(1) and (2) provide for cancellation of nonproducing and producing leases by notice subject to judicial review or appropriate judicial proceedings.

The following table indicates the number of inspections and enforcement actions taken during two separate periods. Minor incidents of non-compliance result in formal warnings while incidents of non-compliance of a potentially more hazardous nature result in well or platform shut-ins until the operation is in full compliance with regulations and orders.

The next table indicates specific items found to be in non-compliance during ten special inspections conducted over a 14-month period.

Basic pollution control items of production equipment in which malfunctions were detected during the following comparable time periods are as follows:

EQUIPMENT MALFUNCTION DETECTED DURING JANUARY
THROUGH NOVEMBER, 1971 SPECIAL INSPECTIONS

	<u>No. Checked</u>	<u>Operable</u>	<u>Inoperable or not within acceptable tolerances</u>	<u>Percent Failure</u>
Surface Safety valves	2392	2306	86	3.6%
Flowline sensors	4166	4081	85	2.0%
Check Valves	2222	2052	170	7.7%
Pressure vessels				
High pressure sensors	908	875	33	3.6%
Low pressure sensors	765	744	21	2.8%
Low level shut-in	511	481	30	5.9%
High level shut-in	<u>460</u>	<u>439</u>	<u>21</u>	<u>4.6%</u>
Total	11,424	10,978	446	3.9%

EQUIPMENT MALFUNCTION DETECTED DURING JANUARY
THROUGH NOVEMBER 1972 SPECIAL INSPECTION

	<u>No. Checked</u>	<u>Operable</u>	<u>Inoperable or not within acceptable tolerances</u>	<u>Percent Failure</u>
Surface Safety valves	1533	1480	53	3.5%
Flowline sensors	3021	2982	39	1.3%
Check valves	1434	1370	64	4.5%
Pressure Vessels				
High pressure sensors	961	942	19	2.0%
Low pressure sensors	610	600	10	1.6%
High level shut-in	351	345	6	1.7%
Low level shut-in	<u>323</u>	<u>314</u>	<u>9</u>	<u>2.8%</u>
Total	8,233	8,033	200	2.4%

Companies fined in District Court for failure to install sub-surface safety devices in offshore oil wells during 1970 in the Gulf of Mexico are presented below. Each company entered a plea of nolo contendere. The maximum fine for violation of the Outer Continental Shelf Lands Act is \$2,000 per count.

Chevron Oil Company	\$1,000,000
Gulf Oil Company	250,000
Tenneco	32,000
Kerr-McGee	20,000
Mobil	150,000
Continental	242,000
Humble	300,000
Shell	340,000
Union of California	24,000
	\$2,358,000

No data for direct comparison of pollution incidences for similar time periods before and after the current "more stringent enforcement policy" are available. However, experienced personnel, private and government, are aware that after public attention was focused on the oil spill at Santa Barbara in January 1969, there has been a great deal less oil pollution in the Gulf from normal oil and gas producing operations. The public awareness, concern, and demand to prevent pollution has been a major factor in the reduction of oil spills.

In the past, major events were catalogued, but less serious events were often not reported. Occasionally, some years ago,

wells were even intentionally flowed into the water for short periods during clean-up operations. Now, sophisticated burning devices are designed to consume this well clean-up oil without air or water pollution. More automatic equipment is now in use to shut-in production whenever a leak occurs in pipeline or production facilities. These include but are not limited to pressure sensors and high and low level controls. Drip pans are placed under valves, vessels, and the production system to prevent leaking oil from escaping into the waters of the Gulf.

New reporting and investigative procedures established in the last two years have increased many fold the number of pollution incidents reported as well as the time spent by GS personnel in surveillance flights by helicopters in assuring proper documentation of pollution events.

4. Contingency Action

Oil spills will occasionally occur as a result of natural disasters, equipment failure or human error. In the event that such an emergency occurs, the following action will be taken:

a. Requirements of OCS Order No. 7

In the case of any spill, the operator is required to initiate action to control and remove the oil pollution in accordance with his approved emergency plan. In any case, a spill or leakage of less than 15 bbls. requires a report from the operator as to the nature of the spill or leakage, why it occurred and what steps were taken to correct it. A spill of 15-20 bbls. must be reported by telephone immediately to GS and confirmed in writing. A spill of over 50 bbls, or one of any magnitude that cannot be immediately controlled, must be reported immediately to the Coast Guard and the Environmental Protection Agency as well as to GS.

b. Regional or National Contingency Plans

If the operator should be unable to control and remove the pollution, the Regional or National Oil and Hazardous

Substances Pollution Contingency Plan may be activated and the designated Federal On Scene Coordinator would direct control and clean-up operations at the operator's expense. This has never been necessary in the case of any spill from OCS operations to date.

The Regional or National Oil and Hazardous Substances Pollution Contingency Plan was developed pursuant to the provisions of the Federal Water Pollution Control Act as amended (33 U.S.C. 1101). Section 11(c)(2) of that statute authorizes the President, within sixty days after the section becomes effective, to prepare and publish such a Plan. The Plan provides for efficient, coordinated, and effective action to minimize damage from oil (and other) discharges, including containment, dispersal, and removal. The Plan includes (a) assignment of duties and responsibilities, (b) identification, procurement, maintenance and storage of equipment and supplies, (c) establishment of a strike force and emergency task forces, (d) a system of surveillance and notice, (e) establishment of a national center to coordinate response operations, (f) procedures and techniques to be employed in identifying, containing, dispersing and removing oil, and (g) a schedule identifying dispersants and other chemicals that may be used in carrying out the Plan, the waters in which they may be used, and quantities which may be safely used. The Plan is revised

from time to time as necessary. Operation of the National Contingency Plan requires a nationwide net of regional contingency plans. Guidelines for that nationwide net are established in the National Plan. This plan provides for a pattern of coordinated and integrated responses to pollution spills by departments and agencies of the Federal government. It establishes a national response team and provides guidelines for the establishment of regional contingency plans and response teams. The Plan also promotes the coordination and direction of Federal, State, and local response systems and encourages the development of local government and private capabilities to handle such pollution spills.

The objectives of the Plan are: to develop appropriate preventive and preparedness measures and effective systems for discovering and reporting the existence of a pollution spill; to institute promptly, measures to restrict further spread of the pollutant; to assure that the public health, welfare, and natural resources are provided adequate protection; to provide for the application of techniques to clean-up and dispose of the collected pollutants; to provide for a scientific response to spills as appropriate; to provide strike forces of trained personnel and adequate equipment to polluting spills; to institute actions to recover clean-up

cost; and, to effect enforcement of existing Federal statutes and regulations issued thereunder. Detailed guidance toward the accomplishment of these objectives is contained in the basic Plan, the annexed, and the regional plans.

The plan is effective for all United States navigable waters including inland rivers, Great Lakes, coastal territorial waters, and the contiguous zone and high seas beyond this zone where a threat exists to United States waters, shoreface, or shelf-bottom. Its provisions are applicable to all federal agencies.

A memorandum of understanding between the Departments of the Interior and Transportation outlines the respective responsibilities of the Geological Survey and the Coast Guard under the National Contingency Plan. The GS is responsible for the coordination and direction of measures to abate the source of pollution when the source is an oil, gas, or sulphur well. This responsibility includes the authority to determine whether pollution control operations within a 500 meter radius of the pollution source should be suspended to facilitate measures to abate the source of pollution. The Coast Guard is responsible for coordination and direction of measures to contain and remove pollutants, and shall furnish or provide for the On Scene Coordinator with authority and responsibilities as provided by the National Contingency Plan.

c. Petroleum Industry Contingency Actions

(i) Inventory of Known Resources Available for
Emergency Oil Spill Control and Clean-up

From the upper Texas coast to the Mississippi Delta region offshore operators maintain a large inventory of various kinds of equipment that could be put to use on shore notice for containing and cleaning up an oil spill and killing the source of the spill. This inventory includes 177 boats ranging from 30 foot crewboats to 165 foot utility and cargo vessels, 64 helicopters, 103 fixed-wing aircraft, over 52,600 feet of spill containment booms, and 103 pieces of skimmers and vacuum equipment. 1/ The distribution of these items is shown in Attachment E.

(ii) Clean Gulf Associates

Clean Gulf Associates is a non-profit organization formed by thirty-three companies 2/ operating in the OCS. Their purpose is to provide for a stock pile of oil spill containment and clean-up materials for use by member companies in offshore and estuarine areas. Clean Gulf Associates has contracted, effective August 1, 1972, with Halliburton Services to supply equipment, materials and personnel necessary to contain

1/ Census of equipment made in September, 1971.

2/ These thirty-three member companies produce 98% of offshore petroleum.

and clean-up spills in the Gulf of Mexico to the limits of the OCS lying offshore and seaward of the States of Texas, Louisiana, Mississippi, Alabama, and Florida.

All of the tracts considered in this proposed lease sale fall within this area. Before any drilling commences, should this proposed sale be held, an inventory of pollution combatting equipment would be stockpiled at a strategic location. Should oil reservoirs be found and production ensue, a permanent base for containment and clean-up equipment would be established.

At the present time, Halliburton maintains four types of recovery/clean-up systems for development at two primary bases located at Intercoastal City, and Grand Isle, Louisiana, and a sub-base at Venice, Louisiana and include:

- (1) Fast response open sea/bay skimmer system
- (2) High volume open sea skimmer system
- (3) Shallow water skimmer system
- (4) Auxiliary shallow water and beach clean-up equipment.

B. Structures

The overall probability that structures will result from OCS leases proposed in this sale is considered high. However, the probability that structures will be erected on each proposed tract is considerably less because past experience shows a success ratio of approximately 35%. This is to say that approximately 1 out of every 3 tracts offered for lease will eventually require the erection of platforms for their development. It is estimated that 5,760 or 5,000 acre tracts which are developed will average 3 structures per tract. Many tracts however, may never be developed. Assuming an average of three platforms per full acre tract, platforms would occupy less than 0.02% of each tract's surface area. Structures can be expected to remain on site for an average period of 15 to 20 years.

If a ship strays from established fairways, oil and gas platforms can pose a hazard to commercial shipping. This hazard, however, is minimized by the fact that fairways are clearly designated on navigation charts. Directional drilling from outside shipping lanes is used to develop tracts lying partially in shipping lanes. Pertinent portions of the Federal Regulations (33 CFR Sec. 209.135 (b), 1971), governing shipping fairways and anchorage areas are as follows:

"The Department of the Army will grant no permits for the erection of structures in the area designated as fairways, since structures located therein would constitute obstructions to navigation. The Department of the Army will grant permits for the erection of structures within an area designated as an anchorage area, but the number of structures will be limited by spacing as follows: The center of a structure to be erected shall be not less than two (2) nautical miles from the center of any existing structures. In a drilling or production complex, associated structures shall be as close together as practicable having the consideration for the safety factors involved. A complex of associated structures, when connected by walkways, shall be considered one structure for the purposes of spacing. A vessel fixed in place by moorings and used in conjunction with the associated structures of a drilling or production complex, shall be considered an attendant vessel and its extent shall include its moorings. When a drilling or production complex includes an attendant vessel and the complex extends more than five hundred (500) yards from the center of the complex, a structure to be erected shall be not closer than two (2) nautical miles from the near outer limit of the complex. An underwater completion installation in an anchorage area shall be considered a structure and shall be marked with a lighted buoy as approved by the United States Coast Guard."

Development of the 10 blocks in this proposed sale which lie totally or partially within shipping fairways or anchorage areas would be subject to Federal regulations as presented above so far as placement of structures is concerned and this would mitigate any adverse impact due to the proximity of structures to relatively high frequency sea traffic.

Commercial vessels are required to report to the Coast Guard whenever a casualty results in any of the following: (a) actual physical damage to property in excess of \$1500, (b) material damage affecting the seaworthiness or efficiency of a vessel, (c) stranding or grounding, (d) loss of life (e) injury causing any person to remain incapacitated for a period in excess of 72 hours; except injury to harbor workers not resulting in death and not resulting from vessel casualty or vessel equipment casualty. Drilling and production platforms (artificial islands) are required to report to the Coast Guard when involved in a casualty or accident and if any of the following occur: (a) if hit by a vessel and damage to property exceeds \$1500, (b) damage to fixed structure exceeds \$25,000, (c) material damage affecting usefulness of lifesaving or fire-fighting equipment, or (d) loss of life.

Under some conditions, offshore structures are an obstacle to commercial fishing activities. Depending on currents and underwater obstacles an offshore structure can remove areas of trawling and purse seining waters. Heavy concentrations of platforms can make trawling and purse seining difficult.

The erection of more structures on the OCS may affect commercial fishing operations. The impact from platforms can be kept to a minimum, however, by only allowing those structures necessary for proper development and production of the mineral resources, and by placing them with due regard to fishing operations.

The Area Oil and Gas Supervisor considers the views of commercial fishing organizations such as the Gulf State Marine Fisheries Committee with regard to placement of platforms. The Supervisor also from time to time requests information from the Department of Commerce, National Oceanic and Atmospheric Administration, and National Marine Fisheries Service to be used in his decision-making process of approving or disapproving platform installation. Within the constraints of location of the reservoirs and the technology necessary to drill directional wells, the Supervisor is mindful that platform location is an important consideration for commercial fisheries and does make decisions to minimize the impact of platform location on the commercial fishing industry.

In an effort to further mitigate the impact of offshore structures resulting from this proposed sale with regard to commercial fishing, it is proposed that the following lease stipulation be applied to all blocks in the Galveston Area, to all blocks in the High Island

Area and to block 46, High Island Area - East Addition in the event they should be leased:

"Structures for drilling or production shall be kept to the minimum necessary for the proper exploration, development, and production of this leased area, and to the greatest extent consistent with the proper exploration, development, and production of this leased area, shall be placed so as not to interfere with other significant uses of the leased area, including commercial fishing. To this end, no structure for drilling or production may be erected within the leased area until the Area Supervisor, Geological Survey, has found that the structure is necessary, on the basis of existing geological and engineering data, for the proper exploration, development, and production of the leased area. The lessee's exploratory and development plans, filed under 30 CFR 250.34, shall identify the anticipated placement and grouping of necessary structures, showing how such placement and grouping will have the minimum practicable effect on other significant uses of the leased area, including commercial fishing."

C. Pipelines

The potential impacts of each specific nearshore and coastal pipeline construction project are considered by the Department in its review of Corps of Engineers permit applications.

Although the environmental statement suggests a possible need for 3 pipelines in order to develop the tracts proposed in this sale, this is at best only a general estimate with no predetermination possible concerning location.

Data concerning the miles and sizes of pipes needed, proposed routes, amount of dredging anticipated, cannot be determined until such time as the exact locations of production have been delineated. The Department will review any application for a pipeline right-of-way that it receives with respect to the specific impact that pipeline may have on the environment. In some instances, it may be determined that a specific pipeline project itself may require preparation of an environmental statement.

The adverse effects associated with pipeline installation can be substantially reduced with adequate planning and by using the most appropriate construction techniques. For example,

pipeline corridors or existing pipeline canals should be used whenever possible so that adverse impacts are restricted to fewer locations. Where possible, pipelines should come ashore on elevated terrain to minimize damage to marshlands. Usually bulkheads are placed in canals to prevent salt-water intrusion and to maintain existing drainage and water-exchange routes. To protect oysters, pipelines are usually routed around major oyster reefs, and where shallow estuaries are to be crossed, the canal is usually backfilled; in many cases so are canals through marshlands. Although all of these measures help to mitigate the problem, the impact of pipeline installation on the coastal environment requires the joint effort of many agencies and authorities for successful resolution.

Agencies having responsibility or jurisdiction over all or part of oil and gas pipeline installation or operation in coastal areas are: (1) Department of the Interior, (a) Bureau of Land Management--rights-of-way for common carrier pipelines on the OCS, (b) Geological Survey--jurisdiction over producer owned gathering lines and flow-lines on the OCS, (c) Bureau of Sport Fisheries and Wildlife--protection of fish and wildlife resources and their habitat through consultation with the Corps of Engineers in the process of issuing Federal permits in navigable waters;

(2) U.S. Army of Corps of Engineers--issues permits for construction (including pipelines) on OCS and in other navigable waters; (3) Federal Power Commission--grants certificates of convenience and necessity prior to construction of interstate natural gas pipelines; (4) Interstate Commerce Commission--grants approval of the tariff rates for transportation of oil by common-carrier pipelines; (5) State of Louisiana--grants rights-of-way through navigable waters under State jurisdiction; and (6) Department of Transportation, Office of Pipeline Safety--establishes standards for pipeline construction, operation and maintenance.

At present, the cooperative effort between the Department of the Interior and the Corps of Engineers and State conservation agencies is responsible for minimizing the impact of pipeline (and other) construction in navigable waters of the United States. The Corps of Engineers, through authority of the Rivers and Harbors Act of 1899, (33 U.S.C. 403) asserts authority over, and requires a permit for construction in all navigable waters subject to the Submerged Lands Act (43 U.S.C. §1301) and includes all lands permanently or periodically covered by tidal waters up to the line of mean high tide.

The Environmental Protection Agency reviews and comments on dredging projects in navigable waters in accordance with a memorandum of understanding with the Corps of Engineers, dated July 13, 1967.

The Department of the Interior and its Bureau of Sport Fisheries and Wildlife has responsibility and authority under several statutes, including the Fish and Wildlife Act of 1956, the Estuary Protection Act, the Endangered Species Act, the Migratory Bird Conservation Act, and the Fish and Wildlife Coordination Act, to preserve, conserve, protect and enhance fish and wildlife resources and their habitat.

The Bureau of Sport Fisheries and Wildlife, with assistance from appropriate State and Federal agencies, including the National Marine Fisheries Service now reviews all applications to the Corps of Engineers for permits to construct pipelines in navigable waters and assesses their potential impact on fish and wildlife resources and the environment. When appropriate, the Bureau recommends to the Corps specific modification of project plans which are needed to reduce impact on these resources. Occasionally a project plan is so conceived that significant impact cannot be avoided, but at the same time, a satisfactory alternative may be available; in such cases, a recommendation that the permit not be issued would be appropriate. At least

one court decision has indicated that the Corps of Engineers has the authority under the Rivers and Harbors Act to condition or deny a permit on the basis of environmental considerations. 1/

Much of Louisiana and Texas marshlands outside of wildlife refuges are privately owned but those that are below the line of mean high tide are subject to Federal regulation (as navigable waters) through application of the Corps of Engineers permit system. Significantly large areas of Louisiana's privately owned marshlands are below mean high tide and are interspersed with waterways or adjoin open tidal waters. Most of the major private marshland owners require that certain protective stipulations must be met or construction methods employed before granting rights-of-way for a pipeline across their property.

Thus, Federal or state 2/ authorities or private marshland owners may require, depending upon circumstances and location, that a pipeline be buried, that canals be backfilled where possible, that

1/ See Zabel v. Tabb, 430 f. 2n 199 (5th Cir. 1970).

2/ The State of Louisiana, by Act 35 of 1971, (LSA, R.S., 51:1362), created the Louisiana Advisory Commission on Coastal and Marine Resources. This Commission is composed of representatives from the fishing, petroleum and transportation industries as well as the State Government, labor unions, and private conservation and recreation groups.

bulkheads be erected to prevent saltwater intrusion, the kind of dredging equipment to be used, the inclusion of shut-off valves, specific placement or disposal of spoil, or, in the case of a private landowner, that pipeline corridors be established.

The Bureau of Land Management has initiated a study to investigate the extent and character of damage to coastal resources from pipeline construction. This is a first priority project of the new environmental analysis team stationed in New Orleans. The second phase, or longer term portion of the study, will attempt to develop criteria for pipeline system planning for application in OCS areas which have not been subjected to extensive mineral development. High priority will be given to developing criteria for the protection of bottom and shoreline resources in this study.

In addition, an interagency study is being initiated to explore the feasibility of pipeline corridors on the OCS and in coastal marshes.

Private industry has also initiated a study of pipeline effects in marsh areas. The Offshore Pipeline Committee 1/ has contracted

1/ The Offshore Pipeline Committee is composed of ten interstate gas pipeline companies.

with Battelle Laboratories to conduct a systematic, comprehensive study of the environmental effects of gas pipeline construction and operation in the Gulf Coast region with emphasis on the Louisiana marshlands. 1/ The purpose of the study is to develop and document existing knowledge on environmental effects of pipeline construction and operation, to identify gaps in existing data, and to state conclusions, based on present knowledge, concerning the impact of pipelining in the marshlands. Phase I of the study, the review of existing information, has been completed, and certain problem areas have been identified. These four major areas which will be subject to further study during Phase II are: the change of marshland to water due to canaling and the associated loss of vegetation; change in local hydrological characteristics such as alteration of water tables, salt water intrusion, and changes in oxygen balance; increased access to wetlands through open canals for hunters, trappers, and sport and commercial fishermen; and the effectiveness of measures which result in minimization of environmental changes.

1/ Testimony of John McGinnis, Associate Chief of the Ecology and Environmental Systems Division, Battelle - Columbus Laboratories, at OCS Public Hearing, New Orleans, Louisiana, August 22-23, 1972.

D. Other Mitigatory Measures

1. Special Stipulations

Leases for oil and gas exploration and development are subject to all OCS operating regulations and orders. Additionally, in some cases the lease may include special stipulations which are considered necessary for the protection of a particular resource. These stipulations can be designed to meet the needs of a particular resource, e.g., wildlife or waterfowl refuges, fishing areas, certain recreation areas, protection of archeological or historical values, etc., which might be quite sensitive to development of the lease. One example of a stipulation used in the past which was designed to protect wildlife refuges and other vulnerable environmental features is worded as follows:

"During all drilling and production activities on the leasehold, the lessee shall maintain, or have available under contract, adequate oil containment and clean-up equipment approved by the Regional Supervisor at a readily accessible site. Within twelve hours after the occurrence of a significant oil spill, as determined by the Regional Supervisor, the lessee shall have such equipment in use at the site of the oil spill, unless, because of weather and attendant safety of personnel, the Regional Supervisor shall modify this requirement. The lessee shall monitor all drilling and production activities either with personnel in the immediate field area or by remote surveillance methods. The proposed method of monitoring and any proposed changes thereof shall be approved by the Regional Supervisor."

Another suggested stipulation has previously been outlined (see sec. IV.B. of this statement) concerning the placement of off-shore platforms in relation to commercial fishing activities. In addition, it is proposed that the following stipulation be applied to any leases resulting from this proposed sale for the protection of historical, archeological or architectural values:

"Upon the discovery of any site, structure or object of historical, architectural, or archeological significance, the operator in charge of any OCS petroleum related activity, including but not limited to, well-drilling and pipeline and platform construction, shall immediately report the finding to the Area Supervisor, Geological Survey, and make every reasonable effort to preserve and protect the site, structure, or object from damage during the course of his operations.

2. Notices to Lessees and Operators

These notices have the same effect or status as OCS Operating Orders and Regulations and are used when expeditious clarification or corrections and additions to existing orders and regulations are necessary. By issuing Notices to Lessees and Operators, the extensive amount of time necessary to amend and re-publish orders and regulations is avoided. One example of a Notice, issued December 11, 1972, explains and details conditions of approval for waste water (oil field brines) disposal from OCS wells at onshore facilities. This Notice provides that such discharges shall meet applicable Federal

Environmental Protection Agency or State standards or effluent limitations, whichever are more stringent, and provides for certain monitoring activities.

3. Departures

A departure (waiver) from OCS orders or other rules of the GS Supervisor may be granted when such a departure is determined to be necessary for (30 CFR, 250.12(b)):

- a) the proper control of a well,
- b) conservation of natural resources,
- c) protection of aquatic life,
- d) protection of human health and safety,
- e) protection of property, or
- f) protection of the environment.

Waivers are technically based decisions and are granted in situations only where expert judgment determines that better, safer operations would result from operations under the waiver.

4. Research on Advanced Technology

EPA and Coast Guard are conducting research on more efficient containment and recovery devices (booms and skimmers). The efficiency of booms and skimmers depends on sea state and spill conditions but in any case are never 100% efficient. When the

results of these studies, and any other similar studies so indicate, the requirement for use of better techniques and equipment will be incorporated into the OCS regulations and orders as appropriate. If incorporated, the requirements will be applied to all leases.

5. Geophysical Information

High-resolution geophysical data covering all tracts to be offered for sale will be purchased and analyzed by GS geophysical personnel. These data, in the area of coverage, provide definitive information on (1) thickness of the unconsolidated sediments; (2) structural configurations on shallow seismic horizons (300-500' below ocean bottom); (3) anomaly maps identifying sea floor anomalies, mud mounds, mud waves or potential slide areas, pipeline and other objects on the sea floor, and bore hole locations as interpreted from a combined analysis of several geophysical measurements, and (4) contoured water bottom maps.

The latest interpretation of high resolution bottom profile data that will disclose bottom and subsurface conditions that might pose special environmental hazards for drilling or producing operations is made available to the Bureau of Land Management OCS Manager prior to his decision as to whether a lease shall be issued and to the Geological Survey Area Manager prior to his approval of drilling operations.

The Conservation Division of the USGS is aware of the near-surface structural configuration and its effect(s) on drilling, fixed-structural emplacements, pipelines, etc., relative to the proposed lease tracts. Knowledge of near-surface structural conditions is fundamental to a sound lease management program for the OCS.

Geophysical data, which show the shallow structural and sedimentary environment, are used to predict, and thus minimize, any geologic hazards to drilling operations and consequent possible dangers to the environment, from pollution. Surface and shallow subsurface geologic hazards, when properly identified and correlated with surrounding strata, seldom create insurmountable obstacles to a minimal risk program of exploration and exploitation of economically attractive structures.

A study of the data over the tracts recommended for the Texas sale does not disclose any obvious hazards to normal drilling operations. The sea floor, over the proposed sale tracts, is essentially flat with few topographic expressions of any kind. The most noteworthy feature observed was a geologic unconformity extending over most of the area of interest. This unconformity is indicative of an old erosional surface covered by terrigenous

deposits. (The few bottom topographic features noted probably indicate deeper structures which have been active during the period of recent deposition.) Good seismic reflections from the near-surface layers indicate a certain degree of compaction and consolidation over most of the sale acreage; however, detailed bottom studies and core hole programs, such as those routinely performed prior to platform location, are necessary to establish the degree of compaction. Some shallow faulting was observed in many blocks; however, appropriate safety precautions should eliminate any risk to drilling operations.

6. Conservation Practices

The Oil and Gas Supervisor, in the interest of conservation, is authorized pursuant to the Code of Federal Regulations, to approve well locations and well spacing programs necessary for proper development giving consideration to such factors as the location of drilling platforms, the geological and reservoir characteristics of the field, the number of wells that can be economically drilled, the protection of correlative rights, and the minimizing of unreasonable interference with other uses of the Outer Continental Shelf. The Supervisor draws his authority from the following regulations and OCS operating orders:

30 CFR 250.11 outlines in broad terms the Supervisor's authority to control development of the OCS, to protect the environment, and to obtain maximum economic recovery of mineral resources under sound conservation practices.

30 CFR 250.17 dealing with well spacing authorizes approval of well locations, platform locations, and lists factors for consideration in this regard. 30 CFR 250.30 requires lessee's compliance with OCS Orders as well as general regulations and demands all necessary precautions to prevent damage, waste, and injuries.

30 CFR 250.34 requires the lessee to submit to the Oil and Gas Supervisor exploratory drilling plans, lease development plans and applications for permits to drill prior to these drilling programs. The Oil and Gas Supervisor utilizes well information such as electric well logs, core information from other wells previously drilled in the vicinity of the proposed drilling program and geological and geophysical data and other pertinent reservoir information to determine the proper number of wells necessary for development.

30 CFR 250.50 grants the Director authority to demand pooling or unitization which the Secretary is authorized to require under the OCS Lands Act in the interest of conservation.

30 CFR 250.51 refers to the unit plan regulations 30 CFR 226 in regard to obtaining approval of units or cooperative agreements.

30 CFR 250.52 lists purposes for which the Supervisor may approve pooling or drilling agreements.

30 CFR 250.16 authorizes the Supervisor to specify the permissible production of a well. Thereafter, OCS Order No. 11 establishes the production rate control at the Maximum Efficient Rate (MER) of the well or reservoir. MER is defined in OCS Order No. 11 as follows: "The MER is defined as that rate for each reservoir and each well which, if exceeded, would lead to avoidable underground waste through loss of ultimate recovery of oil and gas from the reservoir. It is dependent on the recovery mechanism operative for the current producing period, and is based on engineering and geological information."

7. Other Requirements

In addition to the Interior Department's requirements, the operator must comply with applicable navigation and inspection laws and regulations administered by the U.S. Coast Guard. These relate to safety of personnel and display of perscribed navigational lights and signals for the safety of navigation. Permits to install islands and fixed structures and the drilling of wells from mobile drilling vessels must also be obtained from the U.S. Army Corps of Engineers, which is authorized by the Outer Continental Shelf Lands Act to prevent obstruction to navigation. The decision as to whether a permit will be issued by the Corps of Engineers is based on an evaluation of the impact of the proposed work on the public interest. Factors affecting the public interest according to the Corps of Engineers include, but are not limited to, navigation, fish and wildlife, water quality, economics, conservation, aesthetics, recreation, water supply, flood damage prevention, ecosystems, and, in general, the needs and welfare of the people. Pipeline construction must also be in compliance with standards established by the Office of Pipeline Safety, Department of Transportation. The Department of Labor establishes Occupational Safety and Health Standards which are applicable to OCS operations.

V. UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Unavoidable adverse effects from this proposed sale can be identified as follows:

A. Oil Pollution Effects on Marine Environment

Information presented in Section III.E. shows that limited daily oil spillage will occur from the development of the proposed tracts. Accidents associated with oil and gas production sooner or later will occur. The long-term effects of oil spills on the marine environment are not clearly understood. Although local effects of oil spills in this and other areas have been summarized in several reports, the studies have varied in procedure, the extent and composition of the products spilled have differed, and a variety of natural and physical conditions have been present.

The degree of pollution duration, and the physical condition under which it occurs determine the extent of the impact. After pollution has occurred, a normal balance may be regained in a short period of time, or the impact may be more severe and recovery may require a span of many years.

The studies which have been conducted on the effects of oil spills on the environment (some of which are discussed in section III.B. of this statement) seem to indicate that the relative amounts of damage to the natural system from spills of crude oil or Bunker C have been less severe than those resulting from spills of more highly refined fuels. Regardless of the nature of the oil, however, the normal "health" of the ecosystems is disrupted and a balance is lost during the period of recovery.

In areas outside the northwestern Gulf of Mexico, pelagic seabirds have frequently been the most obvious victims of oil pollution because they are likely to come into direct contact with it. Contamination by oil destroys the waterproof qualities of their plumage and leads to a loss of body fat reserves, a condition from which they seldom recover, even when careful rehabilitation is attempted. Similarly, some bird species are vulnerable if beaches and marshes become contaminated by oil, especially if vegetation and food sources are destroyed. In the northern hemisphere, hundreds of thousands of swimming and diving

birds have perished from oil pollution during and since World War II, and marked reduction of some nesting populations of sea birds from such mortality has been documented. 1/

If massive amounts of oil penetrated the bays, and estuaries and their fringing marshes, a severely adverse impact could be expected. Massive mortality could be expected in intertidal reefs and shoreline salt marshes. Death of the salt marsh grasses could be expected to result in large amounts of detrital material 2/ which, along with the spilled oil, would result in extremely low amounts of dissolved oxygen with concomittant fish kills. If oiling is not heavy, only the shoots of the salt marsh grass would be killed and recovery would probably be completed in the following season.

1/ Aldrich, J. W., "Review of the Problem of the Birds Contaminated by Oil and Their Rehabilitation". Resource Publication 87. U.S. Department of the Interior, Bureau of Sport Fisheries and Wildlife, 1970.

2/ Detritus: plant and animal remains.

If oiling is heavy, quantities of oil would probably penetrate the sediment and kill the marsh grass roots, and therefore, the whole plant. This would interrupt the normal food chain and remove vital cover for many valuable species including juvenile shrimp and menhaden.

Oil reaching the sandy Texas beaches could be expected to have an adverse impact on the intertidal and subtidal bottom dwellers and on the small terrestrial plants and animals of the forebeach. Based on past experience, little or no shorebird mortality would be expected.

In summary, the nine tracts identified for oil or oil and gas production in this proposed sale should be given careful scrutiny prior to inclusion in an actual sale due to the potential risk to the environment.

B. Pipeline Construction Effects on Marshes and Bottom Resources

It is possible that three new trunklines will be required to move production of oil and gas from the tracts proposed for leasing in this offering to coastal uplands for processing or redistribution. However, any new pipeline construction in marsh areas resulting from OCS operations could contribute to marsh destruction. The adverse effects can be short term and minor if substrate conditions allow the use of trench-and-backfill or "float-canal" ("push ditch")-and-backfill methods. The adverse effects would be permanent and serious if it was necessary to use an open pipeline barge canal.

Bottom fauna in the path of the pipeline construction, jetting, canals, and burial activity would be obliterated. Some smothering of animals could occur in immediately adjacent areas due to displaced sediment resulting from jetting and dredging. If large amounts of toxic heavy metals are present in the sediments in the path of the pipeline, animal mortalities, food chain contamination, and commercial fish contamination could result as described earlier in this statement.

C. Disposal of Oil-Field Brines

When oil-free brine is released into the open ocean, or when a small amount is released into a large bay, little or no adverse impact results. However, if oil-field brine is released into small ponds and bays, very shallow parts of bays, and tidal creeks, or if OCS-produced brine is added to the already-large volume of effluents being dumped from State-controlled areas, a significant impact could result.

The impact is an alteration or reduction of natural biota by producing physiological stress in two ways: (1) the brine is completely anoxic and may reduce the concentration of dissolved oxygen (by dilution), and (2) it is usually much more saline than sea water and its dissolved minerals are not present in the same ratios as in sea water.

The results in a small creek would be a biological desert.

In somewhat larger channels and ponds, biological productivity would be depressed and the natural community would be replaced by one more pollution-tolerant.

D. Structures in Conflict with Commercial Fishing

All offshore structures interfere with commercial trawling and purse seining operations. This conflict is most intense in shallow areas, where shrimp, menhaden, and bottom-fish harvesting is the greatest. Some shrimping now occurs in deeper waters near the outer edge of the continental shelf, and fishing trends seem to indicate that more effort will be devoted to this deep water fishing in the future. Therefore the conflict may be extended to deeper waters during the life of leases resulting from this proposed sale.

The structures themselves actually remove an insignificant amount of ocean bottom, but trawlers cannot safely pass close to them, and if several structures are clustered moderately close to each other, the entire area within the cluster may be unsafe for trawling. Thus, the expanse of ocean floor effectively rendered unsuitable for trawling may be much larger than the area physically covered by the structures. Unfortunately, the actual amount of seafloor affected has never been determined.

E. Structures in Relation to Shipping

The Ports of New Orleans and Lake Charles, Louisiana, and Beaumont, Texas, are major commercial arteries on the Gulf of Mexico and the United States. Shipping fairways and anchorage areas have been established to permit safe anchorage of vessels while in port and safe passage into and out of the ports.

Despite the installation of navigational aids, the erection of additional platforms on the OCS, particularly those adjacent to fairways, poses an increased hazard to shipping.

F. Oil Pollution Effects on Recreational and Cultural Resources

A major spill or chronic minor spillage could affect some beach areas, water areas and historic sites making them at least temporarily unuseable for recreational purposes. If such pollution incidents occurred during periods of normal heavy visitor use, loss of recreational enjoyment and use and the loss in economic benefit to the vicinity could be substantial.

Water sports, such as swimming, diving, spearfishing, underwater photography, fishing for finfish and shellfish, boating and water skiing would be most directly affected by an oil spill. Other marine-related activities such as beachcombing, shelling, seascape painting, shoreline nature study, camping and sun-bathing would be made much less attractive for an indeterminate period, depending upon the promptness and efficiency of the clean-up effort.

G. Debris Resulting from OCS Operations

Adverse impacts of debris can be summarized as follows:

- 1) Large metal objects which have been lost off platforms, barges, and boats and have sunken to the bottom may cause damage to commercial fishing trawling nets
- 2) Smaller boats can suffer damage by collision with large, heavy floating materials such as wood or metal drums. Floating rope and sheeting can foul the screws of motor vessels and boats
- 3) All floating debris constitutes an aesthetic impact, especially when it floats into near shore areas and becomes stranded on the beach
- 4) Some air pollution results from the regular burning of combustible trash in platform burn baskets.

VI. RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE AND MAINTENANCE
AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The principle short-term use of the proposed sale area will be the extraction of oil and gas from those tracts which prove economically productive. This mineral extraction will contribute to the diminishment of the long-term productivity of the oil and gas resources of the Gulf of Mexico.

The long-term effects of incremental and major spillage of oil on the environment cannot be projected until reliable data become available which will permit an analysis of the net result of the combined effects. This will be a major concern of the Bureau of Land Management's oil pollution study team described in sections III.C.5. and IV.C. of this statement. The additional stress which the ecosystem can absorb is limited, but at present, the bounds of these limitations are not known. St. Amant observes, "Certainly the significance of the continual addition to and accumulative effects of sublethal pollutants in the environment is probably the most important ecological question facing us today". 1/

1/ St. Amant, Lyle S., "Biological Effects of Petroleum Exploration and Production in Coastal Louisiana", Louisiana Wildlife and Fisheries Commission, December 1970, p. 20.

A primary concern is the effect of the breakdown of oil in the marine environment. Among the fractions from the petroleum breakdown are aromatic compounds some of which (toluene and benzene) are very toxic on contact. Other aromatic compounds, including those with carcinogenic properties, are dangerous if ingested, and there is concern that they might be concentrated and transferred through the marine food chain to man. 1/ The regulations under which further development would occur are the most stringent ever promulgated. With strict enforcement of these regulations and their further development, the possibility of adverse effects from the proposed action would be minimized.

Concern has been expressed regarding the possibility of long-term reduction in productivity of the overall ecosystem resulting from continued oil and toxic chemicals being spilled into the water. The possibility that the implementation of this proposed lease sale together with existing production on the Outer Continental Shelf might sacrifice the long-term productivity of the area to the short-term use of mineral

1/ Blumer, M. 1969. Oil pollution of the ocean. p. 5-13. In. D. P. Hoult (Ed.) Oil on the sea. Plenum Press. New York.

resources might be recognized even though the long-term effects of oil spillage into the environment are not clearly understood at this time.

The cumulative affect of structures on multiple-uses in offshore areas where more and more structures are required as OCS production increases is one of concern. The cumulative nature of structures as hazards to commercial shipping and as obstructions to commercial fishing activities represents a use conflict that can be controlled through proper planning and coordination with appropriate Federal and state agencies and private industry. Some levelling out in numbers of platforms is expected as more and more areas go out of production and platforms are removed. This same feature is also expected with regard to the cumulative numbers and length in miles of pipelines to shore. In the case of pipelines, as more and more areas begin to approach termination of production, some additional capacity will be available in existing pipelines to carry production from new areas thereby reducing the numbers of new pipelines required to move production to shore. We are unable to determine at this time if the total number of platforms and pipelines required to develop the OCS areas in the Gulf of Mexico has peaked but indications are that conditions are approaching a levelling off point.

The cumulative impact of pipelines in marsh and estuarine areas is one of environmental concern. The magnitude of this impact could be great or small depending on numerous factors bearing on the degree of disruption of the natural drainage system, sedimentation, vegetation, benthos, plankton, and wildlife in these sensitive areas. If diking and bulkheading are not provided and maintained then increased salt water intrusion and alteration of the natural drainage system in the pipeline right-of-ways will over the long-term result in deterioration and destruction of some marsh lands. The cumulative and synergistic effects that would result from uncontrolled and mismanaged pipeline construction activities in marshes and estuaries might result in the reduction of the long-term productivity of the area in order to exploit the short-term use of minerals production.

To date, there is no evidence that any long-term damage has occurred with regard to the environment as a result of development of the OCS in the Gulf of Mexico.

VII. IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

A. Mineral Resources

The leasing of the proposed tracts in this sale would permit development and extraction of the leasable minerals itself. This lease sale could result in an estimated range of production of 30-60 mm bbl. of oil and 5.4-7.6 tcf of gas which would represent and irreversible and irretrievable commitment of mineral resources.

B. Land

It has been estimated that three new pipelines to shore could result from this proposed sale. If an onshore pipeline does result, then some irretrievable loss of marsh land will be incurred. There will be some topographic changes caused by pipeline installation within the pipeline right-of-way. The amount of land that could be so altered will depend upon the number of pipelines installed, construction techniques employed, the characteristics of the land itself and the degree of proper planning by responsible Federal and state authorities in minimizing any irretrievable land loss.

C. Fish and Wildlife Resources

An irreversible or irretrievable commitment of fish and wildlife resources and their habitats could occur in the area of a massive oil spill or if frequently subjected to chronic low

levels of oil pollution. At this time, there is no evidence that low level spillage has led to an irreversible commitment of resources but there is enough evidence to indicate that this is a possibility that deserves close attention, and constant study.

VIII. ALTERNATIVES TO THE PROPOSED ACTION

A. Hold the Sale in Modified Form

The proposed sale could be held by offering only those tracts determined to have a low potential for environmental harm. Those tracts believed to have high environmental damage potential could be deleted from the sale and considered for offering at a later date, should improved technology or other circumstances warrant. The environmental impact of this possible modification would be essentially the same as that discussed below concerning the offering of gas tracts only because the gas tracts all have a relatively low potential for environmental harm compared with oil tracts. This modification could also allow for special stipulations (including and in addition to those presented in Sec. IV.) on any proposed tracts where additional requirements might be necessary to protect the environment or to minimize or eliminate possible conflicts with, or potential damage to, other resource values or commercial uses of the Gulf of Mexico and the adjacent land areas.

Another possible modification of the proposed sale would be to offer only those tracts estimated to be gas producing. This

would reduce or eliminate the potential hazard of oil pollution.
stemming from this proposed sale.

Development of only gas producing tracts would still require pipeline construction, platform installation and drilling operations with the attendant potential adverse environmental effects discussed in detail throughout this environmental statement for those activities. Generally, if this alternative was followed, the overall importance associated with these activities would be essentially the same as it would be if all the proposed tracts were offered. However, the magnitude of impacts would be reduced and the cumulative impacts associated with quantities of waste water effluents, debris, numbers of platforms and pipelines would be lessened if this modification were adopted. This modification would require elimination of all proposed tracts in the Galveston Area, 9 in all. Elimination of these tracts would result in the loss to this sale of the 30-60 million bbl. of the estimated recoverable reserves for oil which would have to be made up from some other source.

B. Withdraw the Sale

In addition to modification of the proposed sale, all tracts could be withdrawn from leasing consideration. A decision to withdraw the sale completely or to seriously limit the number of tracts to be leased would diminish the contribution of OCS petroleum toward meeting future energy demand, and would subsequently necessitate development of alternative sources of energy.

The oil and gas from tracts projected for leasing at this sale would represent a significant contribution toward meeting domestic energy needs. The sale is expected to contribute to the supply of relatively short-run energy requirements (i.e., 5 to 15 years). Few alternatives exist to help offset the need for domestic oil and gas during this period. The alternatives discussed below are those which may help meet projected energy demands in the event the proposed sale is withdrawn.

The following represents a list of energy sources or actions which, if implemented, might be considered as alternatives to offshore oil and gas in supplying short-run energy needs:

1. Increased oil imports
2. Increased onshore oil and gas production
3. Increased nuclear power

4. Increased use of coal
5. Increased hydroelectric power
6. Modification of FPC natural gas pricing
7. Oil shale production
8. Stimulation of recovery from known deposits
9. LNG imports
10. Synthetic natural gas
11. Energy conservation
12. Combination of alternatives

The general approach used in analyzing each alternative has been to initially review the energy potential of each source in terms of British thermal units (btu's). Restrictions involved in using the available energy as a substitute are then discussed. The sale under consideration primarily involves gas reserves, and it has been necessary to review each alternative from the perspective of ability to substitute directly for the gas or possibly to meet energy requirements now being met by gaseous fuels thereby freeing gas supplies.

The discussion of each alternative includes a general description of the alternative, an indication of the amount of the alternative required to meet projected energy demands that would not be met should the proposed sale be withdrawn, a statement on the technological feasibility of the alternative's being used as a substitute, a consideration of the environmental impact of the alternative, and a description of the impact, if any, on the health and safety of individuals directly or indirectly involved with the alternative.

Supporting analyses for developing the tentative five-year leasing schedule, the linear transportation model for natural gas and a similar study for oil, are useful in determining the extent to which some of the energy alternatives can be regarded as actual substitutes for the estimated oil and gas production from the subject sale. The linear transportation model for natural gas allocates projected supplies of natural gas to consumer demand regions on the basis of least cost and identifies national and regional supply gaps. It gives an indication of what regions OCS natural gas production serves and where the large deficits will exist. The analysis for oil identifies future imbalances in that products market by comparing projections of future supplies and demand forecasts on a regional basis. In some instances, the distance of an alternative source of energy from the projected consuming region which would be served by the expected Texas OCS production precludes that alternative as an actual substitute for the OCS production. This is discussed under the specific alternatives.

Other limitations on substitutability include technology, high development and production costs, and time lag before the alternative could be a viable technical option. In early stages of development of an alternative source of energy, it may serve more as a supplement than as a substitute. Furthermore, there are some cases in which substitutability is diminished because of the

projected use of the offshore oil and gas. These limitations are noted in the individual alternative discussions, when applicable.

The discussion of these alternatives as presented below includes a consideration of the possibility of energy conservation as a method which might decrease or eliminate some of the energy requirements to be satisfied by this sale. A table has also been prepared showing the incremental production potential of the alternatives considered and the possibility of having a combination of sources substitute for the proposed sale.

There are additional potential energy sources which hold great promise for the future. They are not, however, sources which are considered to be reasonably available to meet short-run energy demand, since their utilization will depend on future technologic development, economics, and adequate environmental safeguards.

The development of energy sources such as desulphurization of coal, tar sands, geothermal resources and solar energy are in this category, but the impact of these sources on the energy

supply will not be significant until after 1980. These energy sources are considered to be supplements rather than the alternatives to offshore oil and gas development in the short-run. Therefore, energy sources in this category will not receive examination, at this time, as possible alternatives to this proposed OCS oil and gas lease sale. 1/

1/ These alternatives have received detailed consideration by the Department as part of the Environmental Impact Statement and the administrative review for the Trans-Alaska Pipeline, and are available for examination by all interested parties.

1. Increased Imports

Prior to the final preparation of this section, the working group of the Oil Policy Committee was consulted and suggestions were made on how to improve the analysis. This section has been revised as a result of these comments.

a. Description of the Alternative

Based upon the Department of the Interior's most recent forecast, "U.S. Energy Through the Year 2000", estimated 1980 oil demand will most likely be 20.8 million barrels per day with a domestic production deficit of 11.7 million barrels per day (44 percent of demand). Other projected domestic production deficits, relative to projected demand under the various assumptions considered, range from 8 million barrels per day to as high as 16.2 million barrels per day. Such deficits must be provided for either by (1) reduction in demand as discussed later in this statement, (2) increased oil imports, or (3) development of additional sources of domestic supply, or a combination of 1, 2 and 3. The proposed OCS lease sale would reduce demand for oil to the extent that increased gas production displaced oil usage and would contribute to domestic oil supply. To the extent that the acreage were not leased, an alternative would be to increase oil imports above already expanded levels by an amount equivalent to the expected OCS production. Assuming the continued avail-

ability of foreign oil supplies at competitive prices, two Federal actions could open the way for increased oil imports. First, oil import quotas can be increased in almost any quantity and manner within the context of the existing Mandatory Oil Import Program including removal of controls. Second, all oil import quotas could be replaced by a tariff system design to limit oil imports. The extent of oil imports under restrictive tariffs would be primarily a function of rates imposed, the relationship between foreign and domestic oil prices and transportation costs. A major issue is the extent to which oil import controls are needed to maintain domestic production capabilities required to meet national security needs.

Assuming that there would be no substantive change in U. S. energy policy, analysis indicates that oil imports will need to increase rapidly, either with or without the OCS oil. First indications of this increase are already apparent in 1972. The analysis in this section relates primarily to incremental imports equivalent to the amount of oil and gas expected to be produced from the OCS sale.

The analysis will also be limited primarily to imports into the East Coast area. No significant quantities of Gulf Coast OCS oil will be shipped to the West Coast, and oil imports into the West Coast area are regulated under a separate quota.

(1) Mandatory Oil Import Program

Imports of crude oil, unfinished oil, and oil products are controlled under the Mandatory Oil Import Program established in 1959 by Presidential Proclamation 3279 (17). The statutory foundation for Presidential action started with Section 2 of the Trade Agreements Extension Act of 1954 which prohibited any decrease in duty on any article if such reduction would threaten domestic production needed for national defense. Section 7 of the Trade Agreements Extension Act of 1955 added a sub-section (b) which authorized the President to restrict imports found to be threatening to impair the national security. It established a two-step procedure: an opinion by the Director of the Office of Defense Mobilization (now Office of Emergency Preparedness) as to whether imports of a particular article are threatening to impair the national security, followed by a determination by the President of both the relevant facts and of the action he deems necessary to counteract the threat. The statute was further amended by Section 8 of the 1958 Extension Act in several important respects: (1) to require the President to take remedial action upon a report by the OEP Director, "unless the President determines that the article is not being imported" in a manner threatening the national security, (2) to authorize the President "to take such action, and for such time, as he deems necessary" to adjust imports for the purpose, and

(3) to set forth in a new subsection (c) certain standards to be considered; chiefly the impact of imports on "domestic production needed for projected national defense requirements" and on the "capacity of the U. S. to meet national security requirements," as well as the "impact of foreign competition on the economic welfare of individual domestic industries" so as to determine "whether such weakening of our internal economy may (itself) impair the national security." As so amended, the statutory provisions were incorporated without substantive change into the Trade Expansion Act of 1962 as Section 232.

The stated purpose of the Oil Import Program is to protect the national security by restricting imports from foreign sources, thus insuring a stable, healthy industry in the United States capable of exploring for and developing new hemisphere reserves to replace those being depleted.

The limiting of imports of oil into the United States basically is a problem of balancing a sufficient level of imports with domestic production without depressing or eliminating domestic crude oil exploration, development, and production efforts. It generally is agreed that, were the oil import program to be substantially relaxed or abolished, imports presumably would increase, the domestic price of oil over the short term would fall (perhaps to the price of imported oil if controls were abandoned entirely), short-term

foreign crude prices might rise, and marginal, domestic production would be forced out of production. Further, domestic exploration and development incentives would be reduced resulting in a decline in the development of new domestic oil and gas resources.

(2) Present Operation of the Oil Import Program

On February 20, 1970, the President established the present Oil Policy Committee. He directed at that time that:

"While most day-to-day administrative functions will continue to be performed by the Oil Import Administration (now Office of Oil and Gas) of the Department of the Interior, the policy, direction, coordination, and surveillance of the program will be provided by the Director of the Office of Emergency Preparedness, acting with the advice of this permanent Oil Policy Committee."

The Committee is composed of the Director of the Office of Emergency Preparedness (Chairman), the Secretaries of State, Treasury, Defense, Interior and Commerce, the Attorney General and the Chairman of the Council of Economic Advisors. The Chairman of the Oil Policy Committee makes his oil import recommendations to the President. Upon acceptance, the President then issues such policy in the form of a proclamation. Oil Import Regulations are promulgated by the Secretary of the Interior with the concurrence of the Director, Office of Emergency Preparedness.

Presidential Proclamation 3279 (17), as amended, restricts petroleum imports into the United States by product (commodity), geographical area in the United States and, in some instances, country of origin.

Allocations of imports of crude oil, unfinished oils, or finished products are made for a period of 1 year--that is, January 1 through December 31, except that allocations of imports into Petroleum Administration for Defense (PAD) District I of residual fuel oil to be used as fuel and allocations of crude and unfinished oils in Puerto Rico are made on an annual basis beginning April 1.

Prior to the beginning of each allocation period, the Director of the Office of Oil and Gas determines the quantities of imports of crude oil, unfinished oil, and finished products which are available for allocation in Districts I through IV, District V, and in Puerto Rico respectively. He also determines the quantities of imports of residual fuel oil to be used as fuel in Districts I and V.

Applications for allocations of imports of crude oil, unfinished oils, or finished products and for a license or licenses must be filed with the Director, Office of Oil and Gas not later than 60 calendar days prior to the beginning of the allocation period for which the

allocation is required. Allocations of crude oil and unfinished oils are made to petrochemical firms and to oil refiners. Refinery allocations are made relative to the refinery inputs of the prior 12-month period during September 30. A sliding scale is used to give preference to small refiners.

Allocations and levels for the importation of petroleum are published annually for Petroleum Administration Districts I-IV (States East of the Rocky Mountains), District V (West Coast States, plus Alaska and Hawaii) and Puerto Rico. For purposes of import controls, petroleum imports are generally categorized as crude, unfinished oils, finished products, No. 2 fuel oil, asphalt, and residual fuel oil.

Product imports are almost negligible, except for the importation of 50,000 B/D of No. 2 fuel oil and unrestricted but licensed quantities of residual fuel from overseas sources into District I (the East Coast States plus Vermont and West Virginia), asphalt into Districts I-IV, and finished products manufactured from Canada crude and imported over-land from Canada into Districts I-IV. Imports of other products such as gasoline have been intentionally discouraged to minimize the "exportation" of refining capacity.

Special arrangements are made for imports into Puerto Rico, and for shipments of relatively small quantities of products from Puerto Rico (102,000 barrels per day) and imports from the Virgin Islands (15,000 barrels per day) to the mainland.

Imported unfinished oils (15 percent of the license in District I-IV and 25 percent in District V), as well as crude imports are further processed upon entry into the U. S. These oils are imported primarily by refiners, although some licenses are granted to petrochemical producers.

Allocations to refiners are made according to a sliding scale based on refinery inputs. Petrochemical allocations are computed as a percentage of inputs (11.2 percent in Districts I-IV and 11.9 percent in District V).

The level for imports into District V is computed as the amount required to supplement shipments from other PAD Districts, estimated domestic crude production, and overland imports from Canada so as to meet estimated demand in District V. The level for imports into Districts I-IV other than residual fuel and certain products which enter without restriction (Canadian NGL, Western Hemisphere LPG), was calculated as a percentage of estimated domestic consumption during the early years of the Mandatory Oil Import Program. At the

present time, the quota is computed as 12.2 percent of estimated domestic production in Districts I-IV, plus annual increments of the magnitude recommended by the minority Report of the Cabinet Task Force on Oil Import Control. Although the modified 12.2 percent formula remains the official basis for computing the quota, the annual increment is now based on a comparison of projected supply and demand. On May 11, 1972, the President issued a proclamation raising oil import quotas in Districts I-IV by 230,000 barrels a day. The Canadian quota was raised 30,000 barrels per day while the offshore quota was raised by 200,000 barrels.

On September 18, 1972, the President issued a proclamation increasing the number 2 fuel oil quota by 5,000 b/d for the 1972 allocation period and authorizing eligible overseas importers to import up to 10% of their 1972 overseas allocations during 1972 and 1973, with such imports to be deducted from their 1973 allocations when made. On September 21, 1972, the refiners overseas allocations were increased by 25,000 b/d using oils that had previously been held for contingencies, and Canadian overland allocations were increased by 12,250 b/d using oils not required in the Mexican import program. The quota for Districts I-IV may be allowed to expand further as increases in demand continue to outstrip domestic production capacity.

(3) International Uncertainties

In considering the modification or elimination of the Mandatory Oil Import Program as an alternative to the production of oil and gas from the proposed OCS sale, a particular concern is the security of Middle East supply sources which have been characterized by instability and international tension. The supplies of oil from that area may be subject to interruption for political or economic reasons with little or no advance warning. In their comments relative to the Department of the Interior's analysis of the Economic and Security Aspects of the Trans-Alaska Pipeline, the Secretaries of State and Defense and the Director of the Office of Emergency Preparedness indicated their concern that "failure to obtain desired additional oil supplies (from the North Slope) will necessitate increasing imports from insecure sources to such high levels that a long-term foreign supply disruption could slow down industry and imperil our national security". While the potential production volume from this proposed sale is only a small percent of the North Slope volume, it involves the same types of consideration of different impact scales.

A systematic treatment of the oil import subject is contained in the report of the Cabinet Task Force on Oil Import Control (The Oil Import Question, 1970). While the task force disagreed over preferences for tariffs over the percent quota system as the basic

method of restricting imports, there was concurrence that imports from the Eastern Hemisphere should be limited. Such a limitation would require some type of continuing import controls.

The Oil Import Question identified eight major difficulties that might attend dependence on foreign supplies:

- (1) War might possibly increase our petroleum requirements beyond the ability or willingness of foreign sources to supply us..
- (2) In a prolonged conventional war, the enemy might sink the tankers needed to import oil or to carry it to market from domestic production sources such as Alaska.
- (3) Local or regional revolution, hostilities, or guerilla activities might physically interrupt foreign production or transportation.
- (4) Exporting countries might be taken over by radical governments unwilling to do business with us or our allies.
- (5) Communist countries might induce exporting countries to deny their oil to the West.
- (6) A group of exporting countries might act in concert to deny their oil to us, as occurred briefly in the wake of the 1967 Arab-Israeli War.

(7) Exporting countries might take over the assets of American or European companies.

(8) Exporting countries might form an effective cartel raising oil prices substantially.

A subsequent study made by the Petroleum Industry Research Foundation reexamined the principal assumptions and conclusions of the Task Force regarding U. S. dependency on oil imports in 1980 under various price assumptions (Oil Imports and the National Interest, 1971).

This study raised questions relative to an indicated overstatement of both U. S. production and Western Hemisphere imports and an understatement of demand for imports from the Eastern Hemisphere which in turn raised further questions as to the extent to which the United States should depend on Middle Eastern and North American petroleum sources.

A Joint Economic Committee Background Study relative to the April 15, 1971, OEP Report on price increases in crude oil and gasoline raised the following questions relative to the need for, and effectiveness of the Mandatory Oil Import Program. 1/

1/ U. S. Congress, Joint Economic Committee, Report on Crude Oil and Gasoline Price Increases of November 1970, a Background Study; November 3, 1971.

The security problem has two principal parts: a question of military security, and a question of economic security. Both advocates and critics of the Oil Import Program have tended to focus principally on the economic security issue.

The crux of the argument against importing a substantial fraction of the Nation's oil (and hence, for developing the resources of the proposed OCS sale) is that the sources of additional foreign oil--in general, the Middle East, and North Africa--are "insecure", and might withhold oil exports to the United States for political and/or economic gain.

A study of Drs. Schurr and Homan for Resources for the Future 1/ notes that the question of supply interruptions:

"... needs to be dealt with in the interests of both the importing and exporting countries because supply interruptions are economically damaging to both. Not only do they have sharp short-run effects which are economically painful, but their longer-run consequences can also be damaging if channels of commerce are diverted into alternatives which impose a permanent economic penalty upon both those countries that sell oil and those that buy."

1/ Sam H. Shurr and Paul T. Homan, et. al., Middle Eastern Oil and the Western World: Prospects and Problems. New York, American Elsevier, 1971.

However, this interdependence does not guarantee that interruption will not occur. The study points to interruptions from the shutdown of Iranian production beginning in 1951, the closure of the Suez Canal and attendant lengthening of transportation routes in 1956-1957 and again from 1967 to the present, and quotes Walter Levy, a leading international oil authority and consultant, as saying:

"Nor can the West rely on the importance of uninterrupted oil operations and oil revenues to Middle East governments as a deterrent to hostile actions. Economic considerations, important as they are to the relatively impoverished countries of the area, become insignificant when confronted with political necessities or political pretensions."

Eleven major oil producing countries have joined the Organization of Petroleum Exporting Countries (OPEC), in an attempt to obtain greater bargaining power in their dealings with the international oil companies.

A five-year agreement reached in 1971 with the Persian Gulf countries provides for substantial increases in the payments to the host governments. The other members followed with equal or larger increases. In the second year of the agreement, the OPEC countries have been given further increases to compensate for the devaluation of the dollar, and are demanding participation as part owners in

the oil companies exploiting their resources. If OPEC can maintain cohesiveness in the face of diverse national demands and historical relationships, continuing pressure for economic and political concessions by the oil-importing countries may be anticipated.

Projections of the sources of future U. S. oil imports generally assume that Canadian and other Western Hemisphere oil will be imported to the extent to which it is available and that remaining import needs will of necessity be met from the Eastern Hemisphere.

Projections of potential contributions from Canada and other Western Hemisphere nations are shown in the following table. Additional imports from Canada will require substantial additional discoveries and further development of the tar sands industry in that country. However, tar sands do not appear to be price competitive at present. Canada exports about half its production, which is located primarily in the west, to the United States, but imports slightly more than the amount to the Canadian East Coast. Canada's ability and willingness to maintain and increase its exports depends on its ability to satisfy domestic demands, to increase production, and to find sufficiently stable and attractive markets.

Projections of Imports From Canada and Other
Western Hemisphere Sources
(million barrels per day)

<u>Import Source</u>	<u>Data Source</u>	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>	<u>1985</u>
Canada	Schurr 1/ N.P.C. 2/	0.41	----	0.78	0.95	----
	Draft EIS 3/	--	--	--	--	1.90
	Bu. Mines 7/	--	0.70	1.10	1.60	2.20
	Syncrude 8/	--	0.76	--	--	1.64
		--	--	--	1.63	--
Other West. Hem.	Schurr	1.66	--	2.46	2.82	--
	N.P.C.	--	--	--	--	1.80 4/
	Draft EIS	--	2.20	2.90	3.25	3.50
Total West. Hem.	Schurr	2.07	--	3.24	3.77	--
	N.P.C.	--	--	--	--	3.70
	Draft EIS	--	2.90	4.00	4.85	5.70
Minimum Estimate	Canada	--	--	--	0.95	1.64
	Other W.H.	--	--	--	2.00 5/	1.80
	Total 6/	--	--	--	2.95	3.44
Maximum Estimate	Canada	--	--	--	1.63	2.20
	Other W.H.	--	--	--	3.25	3.50
	Total	--	--	--	4.85	5.70

- 1/ Schurr, Sam H., Paul T. Homan, et.al., Middle Eastern Oil and the Western World: Prospects and Problems, New York, American Elsevier, 1971, p. 28 Schurr gives imports in four categories; Middle East, North Africa, Caribbean, and "Other"; the assumption that "other" represents Canada appears consistent with other projections.
- 2/ National Petroleum Council, "U.S. Energy Outlook: An Initial Appraisal, 1971-1985" Vol. 1, July 15, 1971, pp. 26, 28.
- 3/ Draft Environmental Impact Statement for the Trans-Alaska Pipeline, prepared by Department of the Interior, January 1971, p. 185.
- 4/ Assuming all Latin American excess capacity reaches the United States: see National Petroleum Council, p. 28.
- 5/ Assumed for present purposes, based on the NPC argument that total for 1985 would be 1.80 million bbl/day.
- 6/ Obtained by adding mini. (max.) values for Canada and other West. Hem.
- 7/ Appendix 1, part 3, Vol. II of USDI, "An Analysis of the Economic and Security . . ."
- 8/ Syncrude Submission, exhibit 2, to Proceedings concerning Application No. 5899 to Alberta Energy Resources Conservation Board, September 21, 1971.

The contributions of other western hemisphere nations will be determined by their attitude toward their oil industries (which, though largely owned by the international oil companies, are subject to local government regulations and, occasionally, expropriation), by patterns of domestic demand, export markets in other areas, financial status, and development preferences, so that the projections of export potentials to the U.S. are conjectural.

Although the projections show substantial increases in imports from South America and the Caribbean ("Other Western Hemisphere"), other sources cite declining reserve-to-production ratios in Venezuela and the 6.4 percent annual growth in Latin America demand as evidence that demand in South America will more than absorb any increases in production. 1/ Recent discoveries in Ecuador, though still in the preliminary stage, may yield at least one million barrels per day by the late 1970's. 2/

The following table compares the projected U.S. oil imports from the Western Hemisphere with the overall U.S. crude oil deficits to derive probable levels of imports that would be provided from the Eastern Hemisphere. 3/ It should be noted that if all controls on imports were abandoned, the U.S. deficit would be much higher.

1/ Alberta Energy Resources Conservation Board, Proceedings Concerning Application No. 5849, September 1971.

2/ Oil and Gas Journal, February 8, 1971, pp. 24-26.

3/ USDI, "An Analysis of the Economic and Security Aspects of the Trans-Alaska Pipeline," Vols. I and II, and Supplement 1971.

RANGE OF PROJECTED DEPENDENCE ON EASTERN HEMISPHERE
1980 and 1985
(million barrels per day) (percent of demand)

Year	Contribution of Western Hemisphere	Domestic Deficit Estimate		
		Low (8.1)	Medium (11.6)	High (16.2)
1980	Low (2.95)	5.15 (26%)	8.65 (39%)	13.25 (53%)
	High (4.85)	3.25 (16%)	6.75 (31%)	11.35 (45%)
		Domestic Deficit Estimate		
		Low (11.1)	Medium (16.6)	High (22.2)
1985	Low (3.44)	7.66 (33%)	13.16 (49%)	18.76 (61%)
	High (5.70)	5.40 (23%)	10.90 (40%)	16.50 (53%)

It has been argued that the national security objectives of the oil import program could be met in other ways. Generally, these alternatives are means of coping with an interruption of supplies. They include drawing down oil stocks (which depend on storage capacity); expanding production from remaining sources (with varying incremental volume, cost, and time lag); and reducing demand by rationing (of varying formality and intensity). Such measures are alternatives to the oil import program, not to production from the proposed OCS sale.

b. Incremental Production

The analysis of the previous section indicates that incremental oil imports, alternative to the oil and gas which could be produced by the proposed OCS lease sale, would be obtained from the Eastern Hemisphere, most probably from the Middle East which has 80 percent of the free world's oil reserves. 1/

The expected range of production from the proposed sale is 5,000 to 11,000 barrels of crude and 750 to 1,050 million cubic feet of gas a day. Under the assumption that gas would be exported overland from Canada to the full extent consistent with Canadian energy policy and in view of LNG potential discussed elsewhere in this statement, it is probable that national gas production foregone from the OCS lease would be replaced by imports of oil rather than gas. As the crude oil equivalent of expected gas production would be 133,000 to 187,000 barrels a day, incremental imports alternative to the lease sale would total 138,000 to 198,000 barrels a day.

As noted previously, oil import levels will be significantly higher by 1980 than they are currently whether or not the proposed lease sale is conducted. On the other hand, refinery capacities on the East Coast will be constrained by siting and port limitations and environmental constraints. It is most unlikely that refineries in the East Coast area will have capacities enough to refine as much

1/ Soros Associates, Inc., "Offshore Terminal System Concepts", submitted to U.S. Department of Commerce, Maritime Administration, September 1972, p. 4.

as half of the area's petroleum requirements, about the relationship between refinery capacity and market requirements which prevailed prior to the Oil Import Program. The geographic distribution of products produced would be the same whether the crude oil was from offshore Louisiana or from abroad. It is more difficult to anticipate the distribution of products refined from the crude oil imported to replace offshore gas production. It is not improbable that such products would be used largely for fuel in the Gulf coast area, freeing commensurate volumes of gas for pipeline transmission.

c. Technological Feasibility of Substitution

There are no technical restraints associated with increasing imports as an alternative to production expected from the proposed sale. There is, however, a limit to the volume of imports which can be handled by existing port facilities in the United States. A "superport" proposal to eliminate this restraint is currently under study by both Government and industry.

d. Environmental Impact

The consideration of environmental impacts in this analysis primarily relates to additional ship traffic and oil handling associated with vessels and related handling facilities required for increased oil imports.

Other detrimental environmental effects of increased oil imports are related to the substitution of oil and gas. Since natural gas combustion emits a lower level of particulate and sulphur dioxide pollution, the replacement of the 750 to 1050 million cu. ft. per day would cause a deterioration in air quality.

(i) Increase in Ship Traffic

This analysis estimates that one medium sized tanker (world standards) of 120,000 DWT size will be required every 5-7 days to deliver oil to PAD I (New York) to supply oil equivalent to the oil and gas that would be produced by the proposed OCS sale. It is assumed that the East Coast will have the facilities to accommodate this size tanker.

Because 75% of all petroleum imports to the U. S. land between Virginia and Maine (most are in New York, New Jersey, and Connecticut), the East Coast is particularly susceptible to tanker pollution. 1/ It is estimated that tanker ballasting, loading, unloading, and accidents release about 4 million tons of hydrocarbon pollutants annually into world oceans. 2/ To the extent that it would make

1/ Soros Associates, Inc., "Offshore Terminal System Concepts" submitted to U.S. Department of Commerce, Maritime Administration, September 1972, Table 1-3A.

2/ Blumer, Max, "Oil Pollution of the Sea", Oil on the Sea, David P. Hoult (ed.), Plenum Press, New York, 1969.

more tanker traffic unnecessary, the proposed lease sale presents environmental advantages over increased oil imports.

Three factors are considered in analyzing possible oil pollution as a result of increased imports: (a) intentional discharge, (b) accidental discharge and (c) casualty analysis.

(a) Intentional Discharge

The two primary sources of intentionally discharged oil are shoreside ballast treatment facilities and underway tank cleaning operations. ^{1/} Any development of ballast treatment facilities would be accomplished at the loading end of the system and is discussed in paragraph (iv) below. It may be assumed that all intentionally discharged oil in U.S. waters from this alternative will come from tank cleaning operations.

To assess fully the impact of tank cleaning operations, three separate analyses are necessary; one assuming uncontrolled operations, one assuming load-on-top (LOT) operations, and one assuming compliance with IMCO standards proposed in the 1969 amendments to the International Convention for the Prevention of Pollution of the Sea by Oil, 1954.

^{1/} USDI, Trans-Alaska Pipeline System, Environmental Impact Statement, op. cit.

(b) Accidental Discharges

The 1970 Pollution Incident Reporting Systems (PIRS) data indicate that approximately 0.00015% of the oil handled in the U.S. was spilled during transfer operations. 1/ Applying these figures to the indicated throughput of imported oil, the average volume and number of spills during transfer operations in the New York area would be approximately 0.2 to 0.3 barrels per day.

In the restricted waters surrounding harbors and ports the 1970 experience indicates that about 0.00009 percent of the oil handled is accidentally discharged. 2/ For the New York area, this would amount to 0.1 to 0.2 barrels per day spilled.

(c) Casualty Analysis

The worldwide tanker casualty analysis indicates that an insignificant amount of the total volume of oil transported is spilled, exclusive of transfer operations. 3/ However, it must be recognized that an average calculation such as this has little meaning from an environmental impact standpoint. Such impact could be nominal where small spills are involved or where the spill occurs in such a manner as to have little impact on coastal or restricted water areas. By contrast, a single catastrophic incident such as

1/ U. S. Coast Guard, "Marine Transport Systems of the Trans-Alaska Pipeline System", 1972.

2/ Ibid.

3/ USDI, Trans-Alaska Pipeline System, op. cit.

the breakup of the Torrey Canyon can have disastrous results. The oil spill problem is a subject involving considerable study effort. The first report of the President's Panel on Oil Spills 1/ presents considerable details relative to the subject.

(ii) Terminal Requirements

On the basis of the requirement of one additional tanker visit to the New York area (120,000 DWT size) every 5-7 days, we estimate that no additional terminal facilities would be required to handle the imports necessary to offset production from the proposed OCS sale.

(iii) Off-Loading Facilities

In this analysis, we assume that off-loading facilities presently in place will be sufficient to service additional imports equivalent to expected production from this sale. Oil would be moved from the terminal facilities to refineries by way of existing pipelines. Environmental risks from these operations would be those attendant to normal pipeline operations, e.g., pipeline leaks and more importantly, breaks from construction, anchor dragging, etc. These risks can be minimized by clearly designating pipeline locations and by the use of automatic shut-down equipment that would detect

1/ President's Panel on Oil Spills, The Oil Spill Problem, Executive Office of the President, Office of Science and Technology, First Report, 1969.

any sudden drop in pressure or discrepancy in totalizers 1/ on the line to first shut off pumping equipment and then automatically closing sectionalized valves to minimize the quantity of oil released.

(iv) Pollution Potential at Loading Site

This alternative would result in increased potential pollution at the loading end (foreign ports) where pollution control standards may not be as stringent as United States standards; therefore, this alternative would result in a potential net increase in pollution on a world-wide basis.

e. Health and Safety

Increasing imports as an alternative to that production expected from the proposed OCS lease sale can be expected to increase industry accidents in direct ratio to the increased ship traffic.

1/ Difference in amount leaving platform and amount arriving at onshore facility.

2. Increase Onshore Oil and Gas Production

a. Description of the Alternative

This alternative would require increased exploration, development and production of oil and gas from the Alaskan North Slope or from onshore sources in the lower 48 states. Increasing production in the lower 48 states becomes a meaningful alternative only after positive steps have been taken to maintain present producing rates. Consideration must be given to the current low exploratory and discovery rates, high production levels and continuing declines in reserves and producing capacity. The time required to explore for and develop hydrocarbon production is also relevant as trends in exploration and discovery cannot be easily and quickly reversed. Development of North Slope resources cannot occur prior to the establishment of a transportation system.

Domestic development of oil and gas resources occurred initially onshore; offshore development is relatively recent but an increasing portion of domestic production is now coming forth from the offshore areas. In 1971, 12.03% of the domestic U. S. oil supplies and 12.18% of the domestic U. S. gas supplies came from the Gulf of Mexico. These figures can be compared with the OCS contribution in 1960 of 1.93% of oil supplies and 2.14% of gas supplies. This increasing offshore contribution to domestic production is particularly significant when

viewed in terms of remaining resources onshore and the changing relationship between offshore and onshore potential.

Proved reserves offshore total less than 5 billion barrels of oil and less than 40 trillion cubic feet (tcf) of gas compared with 33 billion barrels and 240 tcf onshore. (Onshore reserves include 9.6 billion barrels and 26.0 tcf on the North Slope of Alaska.)

In terms of "indicated reserves plus undiscovered resources producible with current economics and technology," however, on and offshore potentials are more nearly equal - 171 billion barrels and 840 tcf offshore and 246 billion barrels and 1,260 tcf onshore. 1/

Potential onshore reserves, excepting the Naval Petroleum Reserves (NPR) No. 1 and 4 and the North Slope of Alaska, could be adequate to meet projected demands but recent drilling efforts have not resulted in discoveries sufficient to offset current production.

Proved crude oil reserves in onshore areas of the lower 48 states have declined by approximately three billion barrels within the period 1967-1971 even though recovery efficiencies have increased. During the period 1964-1971, cumulative demand for natural gas

1/ USDI, United States Energy: A Summary Review, pp. 22 & 27.

totalled 152 tcf, or 19 tcf a year, whereas reserve additions only equalled 16 tcf a year. The ratio of reserves to production has fallen to about 8.9 for oil and 11.3 for gas.

Onshore geophysical work, leasing and drilling efforts have declined during the past decade. A number of factors, all adding up to insufficient economic attractiveness of onshore oil and gas ventures, have been cited for the decline. Probably the most significant of all is the increasing difficulty and cost experience by the industry in finding new oil and gas reservoirs sufficiently large to permit economic production. Only 30 new field exploratory wells were needed to find a significant field in the late 1940's; the number of wells required had nearly doubled by 1960 and this trend has not been reversed. 1/

The importance of finding large fields becomes apparent when it is noted that, in 1970, 63 percent of U. S. production was from only 264 of over 35,000 oil fields in the United States. 1/

The fact of the matter is that the onshore areas of the lower 48 states are mature producing areas where the most likely and easiest to find and develop oil and gas prospects have already been "picked over". Most remaining large fields will be more difficult and costly to find unless geologic techniques capable of identifying

1/ Final Environmental Impact Statement, Proposed Trans-Alaska Pipeline, U. S. Department of the Interior, 1972, p. 320.

stratigraphic traps can be developed. Substantially improved economic incentives will be needed to bring these, as well as smaller fields, into production. Additional production could be obtained from onshore sources by expanded application of stimulated recovery methods in existing or new wells. These methods are discussed in a separate section.

b. Incremental Production

The majority of additional production from onshore sources, other than the Naval Petroleum Reserves or the North Slope, will probably be obtained from areas not now deemed competitive. Some increase in the rate of exploration might be expected given a general rise in the prices of oil and gas. A general rise in price, however, would not alter relative economics between the OCS and other producing areas.

Additional production, resulting from increased exploration, will always be associated with a time lag. Periods of at least a year, and in many cases much longer, might be expected depending upon the location and complexity of the new producing area. The expenditures associated with additional exploration and development may be expected to be quite variable. It is reasonable to assume that this additional effort will be reflected in additional costs to the consumer.

Special and specific opportunities for increased onshore production may be found in Naval Petroleum Reserve (NPR) No. 1, California; in

NPR No. 4, Northern Alaska; and in other North Alaska areas including Prudhoe Bay.

NPR 1

Development of spare shut-in capacity in the Naval Petroleum Reserve No. 1, at Elk Hills, Kern County, California could provide as much production as is expected from the proposed OCS lease. Though the current producing rate at Elk Hills is less than 4,000 barrels a day, it is estimated that current facilities are capable of producing about 160,000 barrels a day. This rate could be increased to a range of 267,000 to 350,000 barrels a day with investment in additional drilling, producing equipment and transportation facilities. Congressional approval would be required for any appreciable increase over the current producing rate. Moreover, because of the distance involved, production from this area would not logically flow to those areas where Gulf of Mexico OCS oil production would be marketed.

North Alaska

The Prudhoe Bay field currently is estimated to contain 24 billion barrels of oil-in-place. At an estimated recovery rate of 40 percent, the current proved recoverable reserves of the field are 9.6 billion barrels of crude oil. 1/ These reserves alone make the Prudhoe Bay

1/ American Gas Association, American Petroleum Institute, and Canadian Petroleum Institute, Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States Productive Capacity as of December 31, 1970 (May 1971), p. 27.

field the largest ever discovered on the North American continent. 1/ Nevertheless, the 9.6 billion barrel estimate may be a conservative indication of the crude oil potential of the field and the Arctic Slope province.

The current reserve estimate for the Prudhoe Bay field is for unextended pools and assumes primary recovery only. With further developmental drilling and application of secondary recovery techniques, it is likely that at least 20 billion barrels of crude oil will eventually be recovered from the Prudhoe Bay field. This would make it the fifth largest oil field ever discovered in the world. 2/

The Prudhoe Bay field has large reserves of natural gas dissolved in or associated with its crude oil reserves. Recoverable gas reserves in the field were estimated to be 26 trillion cubic feet as of the end of 1970. 3/ An average of 750 cubic feet of dissolved gas per barrel 4/ for the current oil reserves of 9.6 billion barrels would indicate reserves of approximately 7 trillion cubic feet of dissolved gas and 19 trillion cubic feet of associated gas. These reserves,

1/ Michel T. Halbouty A. A. Meyerhoff, R. E. King, R. D. Dott, Sr., H. D. Klemme, and Theodore Shabad, "World's Giant Oil and Gas Fields, Geologic Factors Affecting Their Formation and Basin Classification," in Michel T. Halbouty, ed., *Geology of Giant Petroleum Fields*, Memoir 14, American Association of Petroleum Geologists (November 1970).

2/ Halbouty, et. al.

3/ Reserves of Crude Oil . . . p. 170.

4/ Suggested by the data given in Bureau of Natural Gas, Federal Power Commission, *National Gas Supply and Demand: 1971-1990*, pp. 98-99.

which, like the crude oil reserves of the Prudhoe Bay field, are subject to extension and revision, constituted 8.9 percent of recoverable U. S. natural gas reserves at the end of 1970. 1/ They also make the Prudhoe Bay field the 13th largest gas field ever discovered in the world. 2/

The estimated reserves of the Prudhoe Bay field do not exhaust the oil and gas potential of the Arctic Slope province in Alaska. The Prudhoe Bay field is located in the Colville Basin. Geologically, this basin is classified as an intermediate crustal type (i.e., its underlying crust is intermediate to that beneath continents and that beneath oceans), the basin itself being extracontinental (located on the margin of a continent) and sloping downward into a small ocean basin. Extracontinental, downward warping basins are among the richest sources of oil and gas in the world. Examples of such basins include the Arabian platform and Iranian basin (Persian Gulf), the East Texas basin, and the Tampico embayment (Mexico). Over half of the 119 known oil fields with at least one billion barrels of recoverable reserves are found in the 10 known basins of this type. 3/

1/ Reserves of Crude Oil . . . p. 124.

2/ National Gas Supply and Demand: 1971-1990, p. 74.

3/ Halbouty, et. al.

The ultimate potential on the onshore area in the Arctic Slope province is uncertain. The platform along the Arctic coast gives considerable geologic indications of being very favorable for both oil and gas. 1/ Comparison with the history of similar basins indicates a high probability of further discoveries of varying size. Professional estimates of ultimate recovery for the province range from 30 to 50 billion barrels. 2/ 3/ Considerably higher estimates than these have been made 4/, but the geologic evidence for them is lacking.

Similarly, the natural gas prospect of the North Slope are not limited to the Prudhoe Bay field. Several gas fields were discovered in the 1940's and 1950's on NPR-4, the largest of which was the Gubik field with 300 billion cubic feet of reserves. Geologic investigations

1/ George Gryc, "Summary of Potential Petroleum Resources of Region 1 (Alaska and Hawaii) - Alaska," and W. P. Brosge and I. L. Tailleir, "The Northern Alaska Petroleum Province," in Ira H. Cram, etc., Future Petroleum Provinces of the United States - Their Geology and Potential, Volume 1, Memoir 15, American Association of Petroleum Geologist (1971).

2/ Ira H. Cram, "Future Petroleum Provinces of the United States - Their Geology and Potential: Summary" in Cram, ed., Future Petroleum Provinces. . . , p. 24.

3/ Sam H. Schurr and Paul T. Homan, Middle Eastern Oil and the Western World: Prospects and Problems (New York: American Elsevier, 1971), pp. 86-87. Personal communications with Richard Meyer, Office of Oil and Gas, George Gryce, U. S. Geological Survey, U. S. Department of the Interior.

4/ Governor Egan of Alaska was quoted in The Oil Daily (July 7, 1971) p. 3, with an estimate of 150 to 300 billion barrels.

of other parts of the North Slope have indicated a favorable potential for future gas discoveries within them as well. 1/

Under the Trans-Alaska Pipeline proposal, all of the North Slope oil to be transported by that line would be delivered to the West Coast (PAD V) within the first few years after full operation. Therefore, oil from that source cannot be considered an alternative for the proposed OCS lease sale since 99 percent of the oil from the proposed sale would be consumed outside PAD V. Deliveries of oil from other fields and by other transportation facilities are too remote and too conjectural for meaningful consideration in current planning.

Given the large size of the Arctic gas reserves and the projected shortages in other sources of domestic supply, there is high probability that this gas will be developed. Three different consortia have made proposals for gas pipelines down the Mackenzie Valley to these potential markets. However, many major uncertainties remain; for example, at this time industry experts differ in their opinions about how soon the gas caps in the Prudhoe Bay field can be tapped. Assuming 750 cubic feet of dissolved gas per barrel of oil produced, only 1.5 billion cubic feet per day of dissolved gas would be produced when oil production reaches a level of 2.0 million barrels

1/ See "The Northern Alaska Petroleum Province."

per day. The additional gas required to meet the full planned pipeline capacity would have to come from the gas caps. The issue may not be fully resolved until several years after oil production begins, at which time empirical data on the effects of production of associated gas on the production of oil will be available. It is likely that a gas pipeline to the Midwest and lower Canada will ultimately transport gas from both the North Slope and the Mackenzie Delta region.

c. Technological Feasibility of Substitution

In general, maintaining and increasing the rate of onshore exploration and development for oil and gas will require new technologies in exploration and recovery. However, the incremental technology needed as an alternative to the volume of production anticipated from the proposed OCS lease sale may not be significant. Problems relating to substitution of energy forms would not arise.

d. Environmental Impact - Lower 48 States

Impact on Air Quality

The impact of additional petroleum production on air quality stems principally from the emission of particulates into the atmosphere; however, some disturbance results from noise and vibrations.

Particulates

Air quality in immediate areas of development will undergo some reduction because of removal of ground cover, dust from vehicle traffic, and from occasional equipment failure or blowouts. Such quality reduction is generally of a temporary nature and has a short-term effect.

Vapor venting from storage tanks and vessels, the burning of waste petroleum and chemical products, especially those containing some sulphur compounds, could result in increase of particulates in the atmosphere and objectionable odors. These impacts on the environment are also of a short-term nature.

Noise and Vibrations

Noise and vibrations from stationary engines used in drilling and production operations and transporting systems disturb the natural environment. The impact exists only for the time-frame that the engines are in use and are local in nature.

Effects of Air Quality Reduction

It is highly unlikely that air quality reductions from operations associated with increased petroleum production would significantly alter conditions affecting the growth of flora. The feeding and nesting habits of birds and animals, wilderness qualities and

hunting could be altered as a result of noise and vibrations associated with increased petroleum operations. After termination of operations, a reversion toward original conditions would be expected.

Impact on Land Quality

The modification of land form necessary for petroleum production results in varying degrees of environmental impacts on the physical and chemical land characteristics, biological conditions, cultural factors, and ecological relationships.

Depending upon the terrain and local conditions, access to the land is normally from existing road networks, extension of these roads, and expansion of trails. For initial exploratory work, minimum alterations are made in roadway systems. After decisions are made to drill in a given area, an improved road system is required for the transportation of heavy loads. The drilling site must be cleared of vegetation which might present obstacles. Once production has been established, newly constructed roads are normally improved. From these operations environmental impact can result from removal of top soil and surface vegetation to establish right-of-way corridors and locations sites, and alteration of drainage patterns and watershed cover.

In the construction of roadways, surface vegetation is removed and drainage patterns are modified. As a result, erosion can occur

resulting in changes in landform. Trees, shrubs, grass, and crops may also be subjected to indirect effects by modification of drainage patterns. Although nature attempts to repair environmental degradation, external help may be required. Soil erosion and siltation can have both direct and indirect impact upon the normal behavior and activity patterns of wildlife. Small animals and birds may not be significantly affected, although their number in the immediate vicinity of the operations might decrease in proportion to disturbances and lost habitats. The habitat may be altered beyond the life of the producing and transporting operations.

Land use and recreation activities may also be disrupted during drilling, producing and transportation operations. Aesthetic and human interest factors are affected for time-frames beyond the terminations of operations. Scenic views and vistas, wilderness qualities, and physical features in some localities could undergo alterations that could be considered permanent transformations. Population density, employment, and cultural life-styles would change from drilling, production, and transportation levels. The change would be of long-term impact and directly affect access, utility networks, waste disposal, and creation of additional corridors. These effects would not necessarily be adverse.

While the construction of pipeline facilities has the potential for causing unfavorable environmental effects, the employment of good construction techniques can minimize or even eliminate most of these effects. Farming or grazing lands can usually be restored to their original condition after no more than one growing season by the replacement of top soil and the replanting of grass or crops. The aesthetics of wilderness areas can be preserved by using existing rights-of-way or minimizing the width of new rights-of-way, by replacing grass and shrubs on the rights-of-way, and by using such techniques as feathering and screening or deflecting entrance-ways. Any displacement of wild animals will occur only during the construction. Banks can and should be stabilized to avoid erosion during construction. Access and service roads should be maintained with proper cover, water bars and appropriate slope to avoid soil erosion. Compressor stations and other above ground facilities can be located in unobtrusive sites and planted with appropriate trees and shrubs to enhance their appearance; location, planting and exhaust design can be used to abate excessive noise associated with operation of the compressor stations. Treatment plants can be located and equipped with devices to minimize any adverse effects upon air quality and suitable means, e.g., evaporation ponds or disposal wells, can be found for preserving the water quality of the surrounding area.

A potential source of land pollution is a blowout during drilling but the frequency of blowouts is small. One hundred and six blowouts occurred in drilling 273,000 wells in 8 major oil producing states from 1960 through 1970. Most blowouts are from high pressure gas rather than oil. Other pollutants from blowouts are drilling mud and salt water. 1/

Impact on Water Quality

Access to Area

The construction of roads for access into prospective petroleum producing areas could affect water quality in that drainage patterns are disturbed and some erosion is possible. The dredging of canals could result in increased turbidity and resuspension of bottom sediments as well as salt water intrusion.

Production Operations

Entry of foreign substances such as oil, chemicals, brine, and waste materials into the water cycle is one of the major environmental risks associated with petroleum production operations. Spills or leaks allowing oil, brine, and waste substances to enter the water cycle can result from human error, corrosion of pipelines and vessels, ruptures or mechanical failures, burning pits, open ditches and blowouts.

1/ Environmental Conservation, The Oil and Gas Industries, Volume 1, June 1971, National Petroleum Council, p. 63.

During production, large amounts of salt water may be produced as oil fields age. Such water can create pollution problems from producing wells on land or freshwater-covered areas. According to a study of the Interstate Oil Compact Commission (IOCC), up to 25 million barrels of salt water are produced daily from the Nation's oil wells. Proper disposal of produced brines has been and continues to be of major concern to producing operators, and regulatory agencies. Subsurface disposal is strictly regulated by some state conservation agencies and disposal of salt water is not permitted in freshwater streams. 1/

Effects of Water Quality Reduction

Removal of vegetation, changes in drainage patterns, and erosion results in turbidity and siltation which reduce the water quality of reservoirs and estuaries. Turbidity is considered to be of short-term duration but may affect local flora and fauna. Siltation of water reservoirs and estuaries has long-range environmental impacts in that the shape and size of the water basin is altered. This can have an adverse impact on flora, recreation activities, aesthetic qualities and perhaps disturb ecological food chain relationships.

1/ National Petroleum Council, Environmental Conservation, The Oil and Gas Industries, Vol. II, 1972, p. 147.

The reduction of water quality and its attendant consequences through the introduction of oil, chemicals, brine, and waste materials into the water cycle ranks as a major environmental risk. The introduction of oil or brine into the water cycle can result in adverse conditions affecting trees, shrubs, grass, crops, and aquatic plants, birds, land animals, and fish. Sheltered lagoons and estuaries impose natural dispersal restrictions on oil spills causing the oil to remain trapped or concentrated in such areas for long periods. Consequently, in some localities, this adverse effect could be long-term. Generally, the degree of reduction in water quality will determine the duration of environmental impact. Major reductions in water quality that significantly disrupt the food chains in bays, lagoons, and estuaries could have long-term environmental effects.

Impact of Operations

Perhaps the greatest adverse environmental impact from operations results from oil, chemicals, brine, or waste material pollution. This pollution can result from spills, leaks, blowouts, human errors, or equipment failure. Although care is exercised to prevent land pollution, there are no fail-safe methods to completely protect the environment.

Land pollution operations, primarily salt water and accidental oil spills, can result in soil sterilization that could be of a long-term nature and affect not only the topsoil but underground water quality. These problems were mentioned earlier. Native vegetation and crops can be adversely affected for short or long-term duration depending upon the volume and toxicity of the pollutant, resistance of the flora, and the techniques and technology employed. Alterations of the flora in turn affect the habitat of birds and animals. Nature has a tendency to overcome the imbalance and in some cases can repair the environmental degradation. Depending upon the degree of pollution, land uses such as agriculture, grazing, forestry, and wilderness can be altered for varying time-frames. In some cases large pollutant concentration could be sufficient to kill vegetation, trees or crops and disrupt wilderness areas for long terms. Recreation in areas subjected to large pollutant concentrations can also be altered for long time-frames.

Depending upon local conditions, aesthetics such as scenic views and vistas, wilderness qualities, unique ecosystems, or historical sites and objects may be altered. The degree of alterations would be dependent upon the degree of pollutant introduction and local conditions. Disruption of ecological relationships such as food chains, salinization of soil and water resources, could result from pollutant contamination. The degree of contamination has a bearing upon the term of environmental impact.

In exploring and pipelining, any spills that occur normally would be small. Major spills could occur in drilling, production, and in the movement of petroleum liquids by marine transportation. The Federal Water Quality Administration (EPA) estimated that 10,000 oil spills occur a year of which 2,500 are ground spills. ^{1/} Most ground spills cause little ground pollution. According to the 1970 report of the Office of Pipeline Safety (Department of Transportation) on spill incidents, there was a total of 347 liquid pipeline accidents. In those accidents, spills averaged approximately 1,780 barrels of crude oil. Principal cause of over 50 percent of accidents was corrosion. Many onshore pipelines are old, dating back to 1920's before techniques for protection against corrosion became widely used. Continued accidents can be expected from these lines. With the development and expanded use of cathodic protection of pipelines, fewer accidents in new lines would be expected, but accidents from old lines will continue to be of concern.

e. Health and Safety

An increase in exploration and development of on-shore oil and gas is not expected to affect the health or safety of individuals living within the area of increased operations. Accidents to those working in the industry are expected to occur at historical rates with any increase being in direct relation to the increase in operations.

^{1/} National Petroleum Council, Environmental Conservation, op. cit. p. 146.

3. Increased Nuclear Power

a. Description of the Alternative

The use of nuclear power as a commercial electrical energy source is expected to increase considerably in the next 15 years. Installed capacity is currently approximately 14,000 MW. The AEC projects capacity will increase to 46,000-61,000 MW by 1975, 120-139,000 MW by 1980, and 198,000-286,000 MW by 1985.

Most of the currently operating and planned nuclear plants utilize light water reactors. In such reactors, the heat energy created in nuclear fission is removed by the circulation of water through the fuel core to generate steam to turn turbine generators to produce electricity. Four high-temperature, gas-cooled reactors are also completed or on order. These utilize helium circulating through the fuel core to boil water to produce steam to turn the turbine generators. These reactors are all of the burner type which utilize less than two percent of the available energy from the uranium which they burn. Breeder reactors, which produce more nuclear fuel than they consume, such as the liquid metal fast breeder, are not expected to be available for commercial use until the mid 1980's. Breeder reactors could utilize more than 60% of the total energy from uranium. Thermonuclear fusion reactors are not expected to be commercial reality much before the year 2000.

Almost all of the reactors in operation today are of the thermal type but considerable effort is being directed toward developing fast reactors which utilize more of the energy of the fuel material. Highest priority is now being placed on the development of the liquid metal fast breeder reactor and a commercial scale demonstration plant is to be built near Knoxville, Tennessee as a cooperative effort between industry and government. Construction will begin in 1974 and the plant will begin operation about 1979. The \$0.5-1 billion project will be financed by TVA, Commonwealth Edison Company of Chicago, and the AEC. The first privately owned smallscale breeder reactor was built by a consortium of Detroit Edison and the Power Reactor Development Company about ten years ago. They failed to renew the operating permit and have filed a plan with the AEC in December 1972 to close the facilities.

b. Incremental Production

On the assumption that all of the oil and gas production from the proposed leases would be used to provide fuel for additional oil and gas fired power plants, five to six additional nuclear plants of 1,000 megawatts capacity each would have to be constructed and in operation between 1980 and 1985. This would be as much as two or more years later than the additional

production would begin from the proposed OCS lease sale. 1/ This would represent approximately there percent increase in planned capacity.

The construction and operation of additional nuclear generating plants would require additional mining and milling of uranium ore to supply the fuel elements for these plants. An incremental operating capacity of 6,000 MW by 1985 would require 3,400 tons of U_3O_8 for the first core fuels and 1,000 tons of U_3O_8 for annual reloads without plutonium recycling and 800 tons of U_3O_8 , with plutonium recycling. At an average ore grade of 0.20 percent U_3O_8 , a total ore output of over 1.5 million tons would be required to supply the uranium for the first core fuels, and an annual output of 0.4 million tons more would be required for reloads. As most of the known and potential reserves are concentrated in New Mexico, Wyoming, and the Colorado Plateau, the incremental mining and milling activity would be expected to occur there.

Of uranium ore reserves at \$8 a pound, about 44% is found in New Mexico, 39% in Wyoming, 4% in Utah, 4% in Colorado, and 4% in Texas, and the remainder is scattered throughout the western United States. Approximately 46% of current production of U_3O_8 comes from New Mexico, 26% from Wyoming, 12% from Colorado, and 7% from Utah,

1/ The proposed leases are estimated to provide 5-11 thousands bbls. of crude oil and 750-1050 million cu. ft. of natural gas per day six years after leasing.

The number of plants in the planning or construction stage indicates that incentives to develop nuclear power facilities are already strong. The inability of utilities to assure long-term supplies of oil and gas has been the greatest stimulus to construction of nuclear plants. However, delays in equipment deliveries, public opposition, environmental objections, and legal difficulties have set back nuclear development.

Since planning, licensing, and construction lead times are at least six to eight years, no new additional nuclear plants could be expected before 1980.

Future costs of electricity produced by nuclear power are difficult to predict on a long range basis. Factors that tend to lower costs include technological improvements, lower fuel expenditure over the life of the plant, larger plants with economies of scale in capital and operating cost, standard components, and improved construction methods. However, because of the lead times involved, nuclear power plants built as alternatives to the proposed OCS lease sale would have to be planned and built with today's technology, the costs of which are well established. Nuclear plants are competitive with fossil fuel plants in most areas of the United States today.

c. Technological Feasibility of Substitution

Given the present energy-using technology, nuclear power can essentially only substitute for oil and gas used by electrical utilities and on site heating facilities. Even here it is not a complete substitute. Nuclear power plants are designed primarily for base load operations and are not expected to displace peaking or cycling units. Electricity produced from nuclear power also could substitute for household heating to the extent that heating oils and natural gas would come from OCS leasing.

d. Environmental Impact of Nuclear Power Generation

Environmental problems which could occur in nuclear power generation are associated with surface and subsurface mining of uranium ore, changes in land use, disposal of waste heat generated by less efficient nuclear plants, a small risk of serious accidents, and the safe storage of highly radioactive waste materials.

(i) Uranium Mining and Milling

Uranium mining is largely concentrated in relatively isolated semi-desert areas distant from large population centers. The removal of vegetative cover and the creation of overburden and waste rock result from uranium mining. In 1970, 53% of production came from underground mines with most of the remainder coming from open-pit mines. Open-pit mines require considerable

acreage, reducing the suitability of the area for other uses such as grazing, wildlife and some types of outdoor recreation.

In underground mining, the extraction of ores requires some accumulation of waste rock in dump areas. Planning for sequential land use, followed by reclamation of mined land and the backfilling of mined-out stopes and pits with waste rock, can substantially reduce land use problems.

In underground mining in the 1950's, excessive exposure to radioactive radon daughter products resulted in a high incidence of lung cancer. However, maintenance of vastly reduced annual exposure limits is expected to decrease incidence of lung cancer to a level just slightly above that of the population as a whole.

Because of low concentration of U_3O_8 in uranium ore, milling the ore produces considerable amounts of low level radioactive tailings that must be retained in well constructed tailings dams to prevent erosion and leaching. Tailings are unsuitable for use as fill material where human exposure might result. To minimize erosion from above ground storage, the tailings should be covered with gravel or dirt upon which a vegetative cover can be established. Above ground storage of tailings requires considerable land area and displaces other uses. In the future, an increasing amount of tailings may be utilized to backfill mined-out stopes and open pits.

Mill tailings are a hostile environment for nearly all biota. The specific adverse effects on overall health of biota are not fully known; current evidence indicates increasing concentrations through upward stages of food chains.

(ii) Plant Construction

Assuming an average of three 1,000 MW units per site, the construction of 6,000 MW of additional nuclear capacity by 1985 could require two additional plant sites (less if some units were added to existing plants). Under current siting criteria, these would be located at some distance from population centers. Assuming 500 acres per site (based upon an exclusion area of one-half mile radius around each plant), these plants would require a total of up to 1,000 acres from which other uses would be excluded.

Depending on the capacity of the transmission lines which would be required if nuclear energy were to substitute for the production from the proposed OCS lease sale, the transmission line rights-of-way would require the use of ten to fifteen acres per mile of line. Certain types of development such as residences, would be excluded although such land would still be largely available for other purposes, such as recreation. These additional transmission lines would have an adverse aesthetic impact by disrupting some scenic vistas.

Construction of the plants would present some short-run environmental problems, such as the erosion of excavated materials. Special measures to prevent erosion of excavated materials with subsequent siltation will be taken.

(iii) Plant Operation

Operation of the nuclear plants will generate considerable amounts of waste heat given their comparatively lower thermal efficiency (around 33% compared to 40% for new fossil-fueled thermal efficiency plants). Given this difference in efficiency and on the assumption that fossil fuel plants release around 15% 1/ of their waste heat directly into the atmosphere, a light water reactor would release approximately 50% 2/ more waste heat into its cooling water than a fossil fuel plant of similar size. The effects of this waste heat will depend upon the cooling method used and the location of the plant.

The use of wet cooling towers, removing the heat by evaporation into the atmosphere, would not pose the problems of adverse thermal effects on water sources used for "once through" cooling. However, water vapor from the cooling operations could have substantial effects on local haze, fog, cloud, and ice formation. Chemicals released in the cooled water or evaporated plume could also have effects on downstream and downwind biota.

1/ Energy Research Needs, Oct. 1971, Section IX, Resources for the Future, p. 19.

2/ Ibid, Section VI, p. 15.

The use of cooling ponds would produce less evaporation than wet cooling towers, but haze, fog, cloud, and ice formation would still occur during periods of sub-freezing temperatures. The ponds require additional acreage (an estimated 1,000-2,000 acres per 1,000 MW unit). These may have recreational uses, but they would also displace previous land uses.

Assuming a 15-20 degree F temperature rise, a "once through" method of direct discharge into the original source for a 1,000 MW plant would require 270-360 billion gallons of water per year. The effects of using a "once through" method of cooling heated water depend in part on the size of the body of water into which this heated water is discharged. The effects along ocean sites, the Great Lakes, and very large rivers are likely to be modest as the heat is more readily dispersed and more easily avoidable by aquatic species. Along smaller lakes and rivers or in bays with limited circulation, the effects can be more significant. Within the affected areas, higher water temperature can produce fish kills, interfere with fish reproduction, disrupt food chains, decrease dissolved oxygen content, drive out desirable aquatic species and encourage the growth of undesirable algae which may speed up eutrophication. However, sometimes the heat can be used for aquaculture and other beneficial uses.

Nuclear power plants, unlike fossil fuel plants, do not emit the usual products of combustion such as particulates, sulphur oxides, and nitrogen oxides. Hence, they do not generate the air pollution problems stemming from or require control measures for, such emissions. However, they do produce radioactive emissions whose release must be strictly limited if adverse affects to the health of humans and other biota are to be avoided.

In the normal operation of the incremental nuclear generating units, there would be very small amounts of radionuclides discharged in the cooling water and gaseous plant effluents. But, assuming that present standards will be maintained and enforced (these limit the release of radioactivity to no more than would expose an individual at the plant boundary to 1% of the individual maximums allowed), the effects of the amounts released are likely to be negligible, as the average additional annual dose which the affected population would receive, would be three to four orders of magnitude less than the average level of natural radiation exposure.

The operation of nuclear plants poses some risk of accidents. Nuclear plants are designed to minimize accidents or their adverse effects if one does occur, utilizing a "defense-in-depth" principle. This includes designing and constructing plants in such a way that

accidents are prevented, designing and constructing plants to contain the effects of accidents which do occur, and siting reactors away from areas of high population density. Plants are designed to withstand a design basis accident (DBA), defined as the worst malfunction considered to have a probability of occurrence high enough to warrant corrective action. For light water reactors, the worst DBA considered is usually a major rupture in the cooling system. The maximum radiation dose which could be received at the site boundary if such an accident occurred is estimated for some plants not to exceed the annual dose obtained from natural radioactivity.

(iv) Transportation

The nuclear fuel cycle requires the transportation of radioactive materials by truck or rail at several stages. The transportation of spent fuel elements from reactors to processing plants and of high-level waste from reprocessing plants to storage sites poses a potential hazard of considerable magnitude. Existing transportation regulations and cask designs have been developed to insure that even if accidents in transporting these materials do occur, no radioactivity will be released to the environment. For the transport of the spent fuels and high-level wastes associated with an incremental 6,000 MW capacity, a very small number of accidents could be expected to occur during a 25-year operating life. However, these are not expected to produce any major adverse effects other than those which could be expected from any other transportation accident.

(v) Fuel Reprocessing

Spent fuel assemblies from reactors are first partially cooled at the plant site and then transported to fuel reprocessing plants where usable nuclear fuel materials are recovered from them and radioactive wastes are separated. Existing reprocessing capacity is sufficient to handle this relatively small incremental load as an alternative to the production from the proposed OCS sale. While radioactive emissions during reprocessing are greater than those occurring during normal power generation, the estimated dose to the affected population is still two orders of magnitude below natural levels. Hence, the impact of these emissions is not expected to be significant, even though the chronic effects of such low level radioactivity are not yet wholly known.

(vi) Radioactive Waste Storage

The high-level radioactive wastes remaining after reprocessing are first concentrated and stored in solution for five years, then solidified, sealed in containers, and put into long-term storage.

The 6,000 MW of incremental capacity would produce around 48,000 to 64,000 gallons of high-level waste per year, using a cumulative storage capacity of 240,000 to 320,000 gallons. This liquid waste, when evaporated, would yield around 480 to 640 cubic feet/year in solid waste materials for each year of operation.

Because of their high concentrations of radioactive nuclides and very slow rates of decay, these waste materials must be isolated from the biosphere for hundreds of thousands of years if adverse effects to living organisms are to be totally avoided. The concept of storage in salt beds has been termed satisfactory by a National Academy of Science Advisory Committee. Pilot studies have been conducted for several years and are continuing to determine the acceptability of the specific sites. In the meantime, waste will continue to be stored in below surface man-made engineered storage facilities.

4. Increased Use of Coal

Since coal is the most abundant fossil fuel in the Nation, full consideration must be given to its use in solid form. A later section discusses the feasibility of coal based synthetic liquids and gases.

The major problems of increased use of coal as a solid fuel are those associated with the meeting of air quality restrictions. These are particularly significant relative to power generation uses since the largest market for coal is in the eastern portion of the Nation and the major deposits of low sulphur coal are in the western states. The Federal Government is contemplating a national standard that translates into a 0.7 percent sulfur in the fuel for new plants regardless of ambient air quality. Assuming that the 0.7 percent sulfur standard becomes effective for plants built after 1972, and no major technological breakthrough materializes before 1980, then it would appear that all coals east of the Mississippi are precluded from the new utility plant market from 1972 onward. Furthermore, many states and cities have adopted regulations that apply to existing units as well.

Considerable research is being devoted to the development of economically feasible processes for the treatment of coal before burning to remove pollutants from stack gases after combustion. Where the quality standards can be met, coal can substitute for oil and gas at

facilities designed to use solid fuels.

The following sections describe the problems related to the mining and processing of coal.

a. Description of the Alternative

The United States is well endowed in coal resources with its deposits underlying 458,600 square miles in 37 states. Coal resources remaining to be produced were estimated by the Department of the Interior in January 1972 at 3,200 billion short tons of which 2,800 billion short tons are at depths less than 3,000 feet, and 1,600 billion short tons are less than 1,000 feet below the surface. Only half of this would be recoverable and less than 5% of this half could be produced under both existing technology and economic conditions.

Of the gross reserve, approximately two-thirds have a sulfur content below 1 percent, but most of these are located in the Western United States and are also of low rank. Four fifths of the North Dakota lignites have a sulfur content of 0.7 percent or less and nine-tenths have less than one percent. The sub-bituminous coals, 60 percent of which are located in Montana and Wyoming, rarely exceed 2 percent sulfur. Illinois, Indiana and Western Kentucky coals, which comprise 29 percent of our bituminous coal reserves, generally have more than three percent sulfur. Approximately 29 percent of our Appalachian

coals have one percent or less sulfur with 42 percent containing between 1.1 to 3 percent sulfur. Most of the lower sulfur Appalachian coals are metallurgical grade and generally not suitable for burning under boilers. 1/

The quality of coal has become increasingly important as restrictions are updated, and new regulations are imposed by local, State, and Federal Governments on the utilization of fuel containing excessive quantities of sulphur, nitrogen, and particulate matter. As a result of these restrictions, low-sulphur coal, or coal containing less than one percent sulphur, is in great demand for power generation, steel, and manufacturing. Throughout the United States, fossil fuel consumers are being forced by public demand and law to use low-sulphur fuels.

At present, the greatest need is for low-sulphur bituminous coal with a low ash fusion temperature for use in the power plants of the eastern United States. There is an acute shortage of this located within an economic shipping distance of the eastern power plants; however, there is an abundant supply of low-sulphur bituminous and sub-bituminous coal and lignite in the Rocky Mountain States. The following discussion will be directed toward that area.

The remaining resources of low-sulphur bituminous and sub-bituminous coal and lignite in the Rocky Mountain States were estimated to be

1/ The Energy Crisis - An Overview - New York Department of Public Service, November 1972.

874 billion short tons as of January 1, 1967. 1/ Of this amount, 188 billion short tons are in beds ten feet or more thick found less than 1,000 feet below the surface. Recoverable resources are estimated at 440 billion short tons to a depth of 3,000 feet and 94 billion short tons to a depth of 1,000 feet. Since 1967, coal production in the Rocky Mountain States has been about 100 million short tons. Therefore, it is assumed that 94 billion short tons are still available as of January 1972. 2/

Approximately 45 billion short tons of the recoverable resources could be extracted by open pit mining, 3/ and 25 billion short tons are sufficiently well known as to character, thickness, and tonnage as to be classified as reserves. 4/

It is estimated that the East Texas sale will produce 5,000-11,000 barrels of oil per day and 750-1,050 million cubic feet of gas per day. The energy supplied by this sale would be equivalent, on an annual basis, to the energy produced by 13-19 million short tons of 11,000 btu/lb. coal. In the five-year period from 1980 to 1985, production from the sale would supply the equivalent of from 65 to 95 million short tons of coal.

1/ Paul Averitt, "Coal Resources of the United States: January 1, 1967" U. S. Geological Survey, Bulletin 1275, p. 1, 1969.

2/ Averitt, 1972, oral communication.

3/ Ibid.

4/ USDI, Bureau of Mines, "Stripable Reserves of Bituminous Coal and Lignite in the United States", Information Circular No. 8531, p. 15.

The coal resources of the Rocky Mountain States, if interchangeable for other energy sources, could be more than adequate to provide the energy needed; however, these resources are far removed by expensive transportation or transmission costs from the area that would be served by the expected Texas production. Other limiting factors are the degree of substitutability of coal for oil and gas and the impact of developing a coal industry capable of producing an additional 95 million short tons of coal during the five year period from 1980-1985.

At present, very large open pit coal mines may produce five million short tons of coal per year. Very large underground mines may produce 2 million short tons per year. In order for the Rocky Mountain coal industry to produce the additional tonnage needed each year from 1980-1985, approximately 9 large underground mines or four large open pit mines, or smaller mines, or some combination thereof, would be necessary. Such mines could become operational only after considerable study of reserves, water supplies, constructing of utility and transportation facilities, and market requirements.

1/ USDI, Bureau of Mines, "Stripable Reserves of Bituminous Coal and Lignite in the United States", Information Circular No. 8531, p. 15.

Finally, a labor force would have to be found and trained to produce the coal within the health and safety standards of the Federal, State and local governments.

About one-half of the remaining coal resources in the Rocky Mountain States are found in thick beds underlying the northern part of the Great Plains. The coal generally has a low ash fusion temperature, a low-sulphur content, a substantially reduced heating value, and high volatile matter content. These characteristics suggest that this coal would be preferred for power generation, gasification, and liquefaction.

The total remaining coal resources in the basins of the Rocky Mountains are very large, nearly as great as those in the Northern Great Plains, but extremely thick beds are a rarity rather than a common occurrence.

At a few localities within the Rocky Mountain States, deposits of metallurgical grade bituminous coal and anthracite are known and some are actively mined. Generally, the coal from these deposits is not suited for power generation, gasification and liquefaction.

The coal resources of both the Northern Great Plains and the Rocky Mountain basins are so large that the locations of open pit and underground mines would likely be determined by nearness to adequate water supplies, transportation facilities, and the plans for mine-mouth power plants. Extensive governmental ownership of the resources indicates that mining, rehabilitation, and environmental controls and procedures imposed on mining operations could be fully effective, since they would be administered in large part by the Department of the Interior and cooperating State governments.

(i) Use of Coal as a Solid Fuel

Recent environmental regulations applicable to new electric generating facilities restrict the emission of sulphur dioxide to 1.2 pounds per million btu of fuel as fired; for bituminous coal, this is equivalent to about 0.7 percent sulphur. It is necessary, therefore, to reduce the sulphur content of the coal prior to burning or to remove sulphur oxides from stack gases following combustion in order that coal may continue to be used for power generation.

Mechanical cleaning of raw coal is not a solution to the problem, since only a small fraction of American coals can be cleaned

sufficiently to meet sulphur emission controls and standards.

Mechanical cleaning affects only pyritic sulphur and leaves untouched the 40 to 60 percent of the sulphur that is bound in the organic structure of the coal. In addition, freeing the small particles in which pyrites occurs requires fine grinding prior to cleaning, which in turn adversely affects the cleaning efficiency and restricts the methods of cleaning that can be applied.

Coal, especially high-sulphur coal, is available in large quantities in close proximity to consuming markets. New coal burning plants could be built if air quality standards can be met but economics for coal desulphurization are marginal and optimistic assessments of economics are generally based on a substantial credit for sale of byproduct sulphur. Recently, the supply of sulphur has exceeded demand and the market cannot be expected to accommodate additional volumes from coal desulphurization.

(ii) Open Pit Mining

Near surface coal (0 to 200 feet)

generally can be extracted by open pit or surface mining. This

method involves the removal of the top soil and rock (overburden) to expose the coal bed, removal of the coal, and replacement of the spoil material and, in some instances, replacement of the top soil. Usually this is accomplished by working in large parallel trenches using the overburden of the second trench, or cut, to fill the first trench.

Surface or open-pit mining of coal has become a major source of solid fuels and, unless restrained by environmental restrictions, all evidence indicates that this method will increase in importance. For example, in 1929, open pit coal production amounted to three percent of the total United States production. 1/ In 1969, however, open pit mining accounted for approximately 200 million short tons or 35.2 percent of the 560 million short tons total U.S. production. 2/ It is estimated that for the year 1971, the amount of surface mined coal will have increased to about 50 percent of total U.S. production.

1/ F. E. Cash and Bernewitz, "Methods, Costs and Safety in Stripping and Mining Coal, Copper Ore, Iron Ore, Bauxite, and Pebble." "Phosphate", USDI, Bureau of Mines, Bulletin 298, 1929, p. 9.

2/ J. J. Gallagher and L. W. Westerstrom, "Coal-Bituminous and Lignite", Minerals Yearbook. Bureau of Mines, 1969, p. 309.

The principal reasons for this growth are: (1) full production can be reached quickly, (2) the coal can be mined more cheaply, and (3) open pit mining is much safer than underground mining.

(iii) Underground Mining

Coal too deeply buried to be extracted by surface mining would be recovered by underground mining. Because most of the coal resources in the Rocky Mountain area are on public, Indian, or State lands, environmental impacts can be minimized by effective enforcement of Federal and State operating regulations.

Exploration activity in the Rocky Mountain States has not been directed towards obtaining the data necessary to design efficient methods of underground mining the thick coal beds. Generally, exploration activities by industry have been directed toward development of near surface reserves for open pit mining. Numerous questions concerning local geologic phenomena and mining conditions remain to be answered about the deeper resources before large-scale underground mines could be efficiently operated at most places. Principal among these are: roof strata thickness, composition, and strength; coal bed continuity, quality and thickness; bottom strata thickness and composition; and the presence or absence of fault systems, aquifers, or explosive gas-bearing strata. In addition to affecting mine safety and production efficiency, these geologic phenomena and mining conditions could strongly influence the environmental impact of large-scale underground mining.

Underground recovery of coal from beds less than ten feet thick averages about 57 percent 1/; however, as coal bed thickness increases above ten feet, the recovery percentage decreases drastically. This decrease is related to the equipment used underground, none of which has the capability of efficiently extracting coal from beds over ten feet in thickness. Equipment manufacturers have not been interested because of a lack in demand in designing machinery specifically for mining thick beds.

b. Incremental Production

Adequate coal reserves exist in the United States to fulfill that energy demand to be supplied by the proposed OCS lease sale.

c. Technological Feasibility of Substitution

Increasing coal production as an alternative to the proposed OCS lease sale would present no new technological problems; however, if the 13-19 million short tons of annual coal production required to replace the energy supplied by the East Texas sale should be furnished totally by surface mines, it is believed that from 3-4 mines of five million short tons annual capacity each would

1/ R. L. Lowrie, "Recovery Percentage of Bituminous Coal Deposits in the United States", USDI, Bureau of Mines, 1968, p. 11.

be required. Currently, a mine of this magnitude employs 610 persons with a capital expenditure of about \$40,000,000. Therefore, in order for surface mines to supply the coal needed annually, 1830-2440 employees would be needed with a total capital expenditure of \$120-160 million. 1/ This capital expenditure does not include the necessary financing for coal cleaning facilities.

If the East Texas sale is not held and if the Rocky Mountain States should have to produce an equivalent amount of energy from coal, the severe short-term environmental impacts of surface mining could be minimized by underground mining. The manpower requirements and capital expenditures, however, would be large. On the basis of an annual production rate of about 2 million short tons per underground mine, approximately 7-9 underground mines would be needed. Manpower for these operations would total from 4-5 thousand employees and capital expenditures would range from 168-216 million. 2/

d. Environmental Impact

Open Pit Mining

There generally are no favorable environmental effects to be found in the immediate area surrounding a surface

1/ National Petroleum Council, Coal Task Group, "An Initial Appraisal, 1971-1985", U. S. Energy Outlook, Vol. II, 1971, p. 136.

2/ Ibid.

coal mine. There are many serious environmental problems that are directly related to open pit mining. Principal among these are:

Open pit mining disturbs a considerable amount of surface acreage. As of 1967, it is reported that open pit coal mines were responsible for 41 percent of the land disturbed by surface mining in the United States. 1/

Predictions regarding the total size of the areas which would be disturbed by the surface mining of nearly 19,000,000 short tons of coal are shown in the following table:

PRODUCTION BY SURFACE MINING METHODS

(BASED ON 1,800 TONS PER ACRE FEET)

(FIGURES BASED ON 19,000,000 TONS PRODUCTION ANNUALLY OVER 5-YEAR PR.)

Coal Bed Thickness (Feet)	Recovery Factor (1%)	Coal Avail. Per Sq. Mi. @ 80% Rec. (Tons)	Area Disturbed Annually (Sq. Mi.)	Area Disturbed (1980-1985) (Sq. Mi.)
10	80	9,216,000	2.1	10.5
15	80	13,824,000	1.4	7.0
20	80	18,432,000	1.0	5.0
25	80	23,040,000	0.8	4.0
30	80	27,648,000	0.7	3.5
35	80	32,256,000	0.6	3.0
40	80	36,064,000	0.5	2.5
45	80	41,472,000	0.4	2.0
50	80	46,080,000	0.4	2.0

1/ USDI, Surface Mining and Our Environment, A Special Report to the Nation, 1967, pp. 53-54.

Additional open pit mining sufficient to satisfy the 95 million short ton energy requirement between 1980 and 1985, could result in the disturbance, and the need for rehabilitation of as much as 6,720 acres of land.

Climatic conditions are extremely important in considering the rehabilitation of mined lands in the Rocky Mountain States. Obviously, without proper moisture, the reseedling of reclaimed lands would serve little purpose and erosion processes would soon destroy the contour of the rehabilitated lands. The following table shows the rehabilitation cost on a per ton basis for varying degrees of restoration.

ESTIMATED COSTS IN CENTS PER TON OF COAL FOR REGRADING, RESEEDING,
AND REVEGETATING STRIP-MINED LANDS TO A PLEASING, NATURAL CONTOUR

Assumed tonnage of coal recovered per acre	Estimated costs of reclamation per acre (dollars)				
	\$1,000	\$2,000	\$3,000	\$4,000	\$5,000
10,000	.10	.20	.30	.40	.50
20,000	.05	.10	.15	.20	.25
30,000	.033	.066	.10	.13	.17
40,000	.025	.05	.075	.10	.13
50,000	.02	.04	.06	.08	.10
100,000	.01	.02	.03	.04	.05

Disruption of the land surface by open pit mining, unless proper precautionary measures are implemented, has adverse impacts on the local environment, leisure time activities in the area, and nearby residential and industrial activities.

Most coal deposits contain contaminants and must be washed. It is assumed that under ideal conditions, a 5-percent washer loss would occur, creating the problem of disposal of approximately 4.5 million short tons of waste material (over 5 years). This problem may not be critical for surface mines where pits, from which the coal would be extracted, could receive this material. Ultimately, the mine pits would be backfilled, levelled, the top soil replaced, and the area reseeded.

Other problems related to surface coal mining are acid water developing in the open pits and in spoil piles, erosion of pits, and dust. Each of these problems can be handled effectively by requiring the mining companies to observe environmental regulations. However, if they are not handled properly, damage can occur to the local environment. Additionally, area downstream of the mine and processing plant could be adversely affected.

Surface mining operations also generate fairly significant volumes of noise and vibrations. Modifications of the habitat, alteration of ground cover, alteration of drainage systems, destruction of land

forms, and siltation of nearby streams may also occur. With the implementation of proper rehabilitation and environmental safeguards, the unfavorable impacts described can be reduced to short-term problems. Proper supervision within the scope of present environmental regulations would result in mined lands being returned to "as good or better than found conditions", in that some restored lands could lend themselves to recreational sites, lake impoundments for boating and fishing and picnic areas. The short-term economic and energy profits derived from surface mining can be realized without long-term degradation of the environment if there is complete cooperation between all companies, land owners, and governmental bodies acting in concert.

TRANSPORTATION

Once mined, the impact of coal production is still felt in the transportation to the market areas. One way to eliminate this impact is to situate new power plants at or near mine locations. The transport of electricity to the market areas by transmission lines causes fewer environmental problems than the transport of a vast quantity of coal.

If the transport of the coal itself is necessary, four systems would be available to the Rocky Mountain States. These systems are: trucks, railroads, conveyors, and coal slurry pipelines.

A fifth system, water transportation, may be discounted because of the lack of navigable waterways. Each system has advantages that make it economically attractive. Selection of a system would be strongly influenced by the distance to a utilization plant. Relative costs of coal transportation systems are given in an attached table.

Truck transportation is commonly used for relatively short hauls, as in supplying mine-mouth utilization plants. The roads are usually less than 5 miles long, on land leased by the mining company, and have little effect on the general public. In the Rocky Mountain States there are usually no intersections with public roads and the traffic is generally related to the mining operations. Trucks can transport ash and spent plant materials back to mine pits for disposal, thereby using the haul in both directions as well as solving a refuse disposal problem.

Transportation Cost in Mills Per Ton Mile

	<u>Maddex 1/</u>	<u>Aude 2/</u>	<u>Wellman 3/</u>
Ocean shipping	0.3-10		
Pipeline	1.5-10	3-7 (More than 50 miles no slurry preparation)	
River barge	2-4		
Railroad	4-15	4-9 (Unit train more than 400 miles)	
Truck	55-70	50-80 (One way haul with empty return)	
Conveyor belt		20-60 (Less than 15 Miles)	
Pneumatic			130 (600 tons per hour, 5 miles)

1/ Philip J. Maddex, and Ole Skaarup, "The Cost of Transporting Ores and Raw Materials in World Markets ", Mining Engineering, June, 1970, pp. 56-57.

2/ T. C. Aude, N. T. Couper, T. L. Thompson, and E. J. Wasp, "Slurry Piping Systems: Trends", Chemical Engineering, June 28, 1971, pp. 74-90.

3/ Paul Wellman and Sidney Katell. "Economic Evaluation of Pneumatic Transport of Coal at 200, 400 and 600 tons per Hour. Paper in Pneumatic Transportation of Solids, Proceedings: Institute of Gas Technology, Bureau of Mines Symposium, Morgantown, W. Va., October 19-20, 1965. Compiled by J. D. Spenser, T. J. Joyce and J. W. Faber, 1966, p. 184.

The impact of rail transportation varies to some degree with the types of motive power used. Diesel locomotives are sources of exhaust gas and noise pollution; electric locomotives are not sources of air pollution per se; however, the pollution source is the power station. Positive factors include the transporting of commodities to fulfill the needs of inhabitants in the area and haulage of ash and spent materials back to the mine pits for disposal.

Rail installations can be constructed to lessen the impact on the environment. Ribbon rail with thermite welded joints can be installed to reduce track noise. Rights-of-way can be fenced for safety to animals and humans, with underpasses and grade separations provided for heavily traveled roads. Coal hoppers can be partially covered, or the coal can be sprayed to reduce dust loss in transit. Coal loading and unloading facilities can be designed to consider aesthetics. Cut and fill areas can be constructed with gentle slopes to permit the growth of vegetation and borrow areas can be covered with top soil and then revegetated.

Overland conveyor systems are used to transport coal from mine to preparation plant, from truck or railroad unloading hoppers to storage areas or bunkers and directly to some utilization plants.

Generally, these installations are short; however, they may be as long as 15 miles. Although conveyor structures and transfer point housings are obvious intrusions on open space vistas, this impact can be lessened through selective use of colors. Rights-of-way for conveyor installations require less land than either truck or rail rights-of-way and do not require the extensive cuts and fills needed by other transport systems.

The least obtrusive type of transportation system from both land use and visual standpoints, are coal slurry pipelines. Land surface requirements are minimal because the pipeline is buried and appears at the surface only at drainage crossings and pumping stations. Slurry preparation plants, pumping stations, and terminal coal dewatering and storage facilities are the only permanent structures. The pipeline, after burial, does not interfere with the free movement of vehicles, people or animals. The only noise sources are at the slurry preparation plant and at pumping stations. Dust problems associated with pipelines are confined to the slurry preparation plant where the coal is crushed, screened and stored and commonly employed suppression methods minimize this problem.

The major adverse environmental impacts of the transportation systems are air and noise pollution, safety, the amount of land required for rights-of-way, trash disposal and aesthetics.

Air pollution sources are exhaust emissions, road dust, and coal dust. The level of adverse exhaust emissions can be reduced through efficient engine maintenance; road dust can be reduced by haul-road surface treatment such as hard surfacing, oiling, or applying water-chemical solutions; and coal dust can be reduced by truck covers and spraying. Although mufflers can reduce the level of noise pollution, truck haulage, because of the large number of noise sources and frequent trips, is commonly recognized as the noisiest system of transportation. Truck haulage also requires the commitment of more land than any other coal transportation system.

Rail transportation systems using diesel locomotives are sources of air and noise pollutants from engine exhaust systems. Effective maintenance of engine combustion systems and efficient mufflers can reduce the air and noise pollution levels from these systems. Coal dust lost in transit can be reduced by using partially covered hoppers or by oiling the coal during loading. Dusting during loading and unloading can be reduced with a combination of dust suppression sprays and enclosed chutes or bins.

The right-of-way for a railroad constitutes a permanent commitment of the land surface to this use making it unavailable for other uses. Free travel of vehicles, people and animals across

the committed area is restricted. The potential for collisions with trains exists.

In the open or scenic areas, railroad rights-of-way may be considered as aesthetic intrusions, especially if large trestles, overpasses, or cut and fill areas are required. Cut and fill areas can be reclaimed as mentioned earlier. The visual impact of trestles, overpasses, and other appurtenant structures can be minimized with effective combinations of eye-pleasing designs and unobtrusive colors.

Conveyor system installations likewise constitute a permanent commitment of the land surface and restrict free movement of vehicles, people, and animals. The right-of-way width is less than that required for truck or railroad transportation systems. Uncovered or partly covered conveyors allow loss of dust in transit because of exposure to winds and falling material may constitute a safety hazard to persons or animals. Conveyor systems, fenced or completely enclosed, can reduce or eliminate these hazards. Conveyor support structures, either frame or suspension type, as well as the conveyors, are obvious visual intrusions. Color treatment of support structures, enclosures, and transfer structures can lessen this impact.

The principal impacts of coal slurry pipeline systems are: the permanent commitment of land; providing an adequate water supply; and water disposal. Large quantities of water, at the rate of one ton of water per ton of coal, are required to transport coal in the Black Mesa, Arizona, Pipeline 1/. In water deficient areas, this method may not be an efficient transportation alternative.

Water disposal problems at the terminus of a pipeline could have an impact on water quality if not properly contained or when not economically feasible to recycle the water for transportation purposes. Coal slurry destined for power, could be dewatered, the "spent" water used for cooling tower makeup, ash handling, and/or evaporated in disposal ponds. The Mohave generating station in Nevada is utilizing water from the Black Mesa Pipeline in this manner.

The disposal of solids and water removed from sections of a plugged pipeline could cause environmental impacts. Holding ponds, equal in capacity to the upstream pipeline, could be provided at pumping stations and at the coal slurry preparation plant for disposal of removed plugs. The water could be evaporated and the coal could be left in the impoundment unless provisions are made

1/ J. M. Arnold, "Discovery and Development of Peabody Coal Company's Black Mesa Mine", Society of Mining Engineers and American Institute of Mining and Metallurgical Engineers, Preprint No. 69-F 349, 1969, p. 8.

for recovery. Compaction and sealing would prevent spontaneous ignition, erosion, and accompanying siltation of the coal left in impoundments. The surface of the impoundment can then be revegetated to prevent erosion.

MINING WASTE

Large volumes of waste are generated during coal mining and processing. The volume of mine waste depends on the type and characteristics of top and bottom strata, the continuity of a coal bed, the tonnage mined, the amount of waste material included, the specifications for which the coal is being prepared, and the efficiency of the processing equipment. Uncontrolled disposal of waste, especially that containing carbon and sulphur, constitutes a source of pollution. Water flowing over waste disposal areas may transport leached minerals to adjacent areas. Dust-size particles commonly are transported by winds to contaminate adjacent land. Noxious gases from burning waste may be hazardous to plants, animals and people. 1/

Waste disposal areas require a commitment of land resources and, if poorly constructed, present an unattractive appearance to

1/ L. M. McNay, "Coal Refuse Fires, An Environmental Hazard", USDI, Bureau of Mines, 1970, p. 8.

viewers. Slides and slump failures, where waste is deposited on slopes, may not only adversely effect land and water resources but also create a safety hazard.

Construction of slurry impoundments on underlying previous bedrock may result in pollution of the ground water. Percolation through the base of dikes permits slurry water to reach downstream drainage systems. Unless measures are taken by coal operators to seal this type of disposal area , unfavorable impacts can continue for decades. However, use of appropriate treatment methods on the part of coal operators, coupled with effective enforcement of waste disposal regulations promulgated by State and Federal Governments, can minimize such effects on the environment.

There can also be beneficial uses of waste materials. The rock removed during mining may be used as landfill providing an effective method of disposal.

Underground Mining

Subsidence of the ground surface is common above any abandoned and some active coal mines. The amount of subsidence relates to the mining method employed, the amount of coal removed, the thickness of the coal bed, and the composition and strength of

rocks overlying the coal. Subsidence of large areas commonly destroys man-made structures and disrupts the ground water hydrology, cuts off surface and subsurface water recharge, adversely affects the quality of underground and surface waters, redirects the planned drainage of a mine, disrupts surface drainage, and in periods of heavy rainfall localizes flooding. It also, in some localities, causes land slides.

The most successful method of preventing or alleviating surface subsidence problems is to plan mining so that more pillars are left untouched. Unfortunately, this procedure results in less coal recovery. Pillars can be constructed of timbers and rock to make possible the mining of more coal than by simply leaving coal pillars in place to support the roof. Much additional research is needed to develop methods of underground mining which will minimize subsidence of the surface. If such methods cannot be implemented, the best solution may be to achieve as complete recovery of coal as possible during mining, then allow controlled subsidence to the point of natural stabilization and, finally, develop the land surface.

Ground and surface waters entering active underground mine workings are normally pumped to the surface for disposal. Because of the low-sulphur content of most Rocky Mountain coals, it is uncertain whether acid-mine water would be a problem in areas of large-scale mining and above average precipitation. If acid-mine water problems should develop, it is likely that the modern treatment methods employed in the coal fields of the eastern United States could be implemented to abate their impacts. The large volumes of sludge resulting from such treatment could be emplaced either in abandoned mine workings or in protected disposal areas. Drainage of acid-mine water may be prevented by locating mine entries at elevations above the prevailing drainage level, by sealing abandoned mine entries, and by emplacing dams at critical points in abandoned underground entries and haulageways.

Unless controlled, mining and processing wastes contribute large volumes of sediment to nearby streams, are sources of acid drainage and, where waste piles are burning, are sources of air pollution. The most commonly used technique of preventing widespread scattering of mining and processing wastes is to compact the waste layers, followed by sealing with incombustible soil, after which vegetation is established to prevent infiltration of surface water and to minimize erosion.

An alternative to surface disposal of mine and coal processing waste is to return wastes to abandoned underground mine workings. This is currently being done to control surface subsidence in mined areas in compliance with restoration provisions of the Appalachian Regional Development Act of 1965, as amended. 1/ Methods of returning the waste to mined out areas concurrent with active mining would appear to warrant attention of mining method researchers.

Dust from mine access roads, coal handling, and processing can be alleviated by hard surfacing roads, or through abatement techniques such as oiling or chemical treatment of the road surface. Dust from coal handling and processing can be abated by spray treatment at transfer points and by enclosing coal handling and processing structures. Dusting problems in live coal storage piles can be reduced by water sprays or oiling; dead storage piles can be sealed with asphaltic or chemical materials.

The potential for long-term environmental impacts from an underground mine can be diminished by identifying and eliminating pollution sources prior to closure of the mine. Most pollution sources can be eliminated by sealing and revegetating waste

1/ C. B. Kenahan and E. P. Flint, "Research and Programs on Recycling and Disposal of Minerals, Metal and Energy-Based Solid Wastes", USDI, Bureau of Mines, 1971, p. 24.

disposal areas; sealing and removing abandoned mine buildings and structures; and scoring, fertilizing, and revegetating disturbed surface areas. Consideration should also be given to flushing all wastes and plant refuse into underground mine voids to remove sources of surface pollutants and to reduce possible surface subsidence.

A discussion of the favorable environmental effects of underground mining follows:

When subsidence of the land surface is prevented, the surface effects of underground mining generally are confined to the areas occupied by mine buildings, dumps waste disposal banks and impoundments, water supply impoundments or wells, coal transportation systems, power supply structures, and mine supply storage yards.

The areal extent of environmental impacts associated with underground mining is dependent on the mining system being designated to assure a high level of environmental quality. Means of obtaining this assurance are State and Federal regulations, and the development of an environmental ethic by all mine operators. The Mined Area Protection Act of 1971 (S. 993 and H. R. 5689), currently being considered by the 92nd Congress, is an example of pending legislation that would require all underground and surface operators to adhere to standards designed to protect the environment.

Several provisions of the mandatory safety standards issued under the Federal Coal Mine Health and Safety Act of 1969 have related environmental objectives, especially those standards for disposal of mine refuse and dust, for coal handling, and for transportation facilities.

Most older coal leases on Federal lands include a provision in the lease agreement for the protection of the land surface, natural resources, and improvements. This provision has been broadened over the years to include environmental considerations.

Underground mining is subject to minimal noises and vibrations and the surface environmental effects are of limited significance. Modifications of the habitat, alteration of ground cover, alteration of surface drainage systems and the necessity of fertilization application are also minor. The following environmental effects of underground mining, however, pose problems: alteration of ground water hydrology, the necessity of well drilling and fluid removal, the techniques of product processing and resultant waste, liquid effluent discharges and most accidents.

Many unfavorable environmental impacts of underground coal mining can be controlled largely through techniques developed and used in recent years. Prevention of environmental degradation by underground mining is dependent upon attitudes of mine operators and efficient enforcement of local, State and Federal regulations.

e. Health and Safety

Costs in terms of health and safety of mine employees must be considered along with the capital expenditures and environmental costs of mining.

In 1970, there were 31 fatal and 1,010 non-fatal accidents connected with open pit mining. Underground mining was responsible for 219 fatal and 8,710 non-fatal accidents in 1970. These figures may be compared to the 15 deaths and 81 injuries associated with offshore production in the Gulf of Mexico in 1971.

Black lung disease has been a serious problem in the past. Recent regulations and technological advances concerning the control of the quantity of dust in mining operations, however, hopefully will go a long way to reduce or eliminate this coal mining associated health hazard.

5. Increase Hydroelectric Power

a. Description of the Alternative

The generating potential of any hydroelectric site is a function of both stream discharge and the height of fall; hence the better hydroelectric sites are concentrated in areas with heavy precipitation and large topographic relief. The following table shows the extent of U. S. potential and development of conventional water-power capacity:*

<u>Geographic Region</u>	<u>Potential Power (10³ MW)**</u>	<u>Percent of Total</u>	<u>Developed Capacity (10³ MW)</u>	<u>Percent Developed</u>
New England	4.8	2.7	1.5	31.3
Middle Atlantic	8.7	4.8	4.2	48.3
East North Central	2.5	1.4	0.9	36.0
West North Central	7.1	3.9	2.7	38.0
South Atlantic	14.8	8.2	5.3	35.8
East South Central	9.0	5.0	5.2	57.8
West South Central	5.2	2.9	1.9	36.5
Sub-total	52.1	28.9	21.7	42.0
Mountain Pacific	32.9	18.3	6.2	18.8
Alaska	62.2	34.6	23.9	38.4
Hawaii	32.6	18.1	.1	0.3
	0.1	0.1	-	-
TOTAL	179.9	100.0	51.9	28.8

Of the potential hydroelectric capacity of 179,900 MW in the U. S., 95,400 MW is yet to be developed in the lower 48 States. Of this, 30,400 MW is the potential for additional hydropower east of the

* Statistics as of January 1971 obtained from FPC.

** MW = Megawatts

Mountain States. Hydropower from Alaska, the Pacific or Mountain areas of the U. S. probably cannot be considered as sources of additional hydropower for the Eastern U. S. largely because the distance from consuming region and the related transmission problems would make the construction of transmission lines economically infeasible.

b. Incremental Production

The Federal Power Commission projects conventional electric generating capacity in the contiguous U. S. as follows:

<u>Year</u>	<u>Total Generating Capacity (MW)</u>	<u>Total Conventional Hydro Capacity (MW)</u>	<u>Conventional Hydro as Percent of Total</u>
1970	340,000	51,600	15.2
1980	665,000	68,000	10.2
1990	1,260,000	82,000	6.2

The geographic distribution of the projected 16,400 MW increase in conventional hydro capacity in 1980 over the 1970 capacity for the contiguous U. S. is as follows: 1/

<u>Geographic Region</u>	<u>Incremental Hydro Capacity (MW)</u>
Northeast	1,200
East Central	1,000
Southeast	1,700
West Central	- 500
South Central	<u>700</u>
Sub total	4,100
West	<u>12,300</u>
TOTAL U.S.	16,400

1/ Federal Power Commission, The 1970 National Power Survey, Part 1, p. 1-18-29.

Of the total incremental conventional hydroelectric capacity of 16,400 MW, 4,100 MW can be expected to come from areas other than the West, leaving some 25,000 MW to be developed in those areas. If all of the remaining potential 25,000 MW were developed by 1980, hydropower might approximate the energy value of the proposed East Texas sale.

c. Technological Feasibility of Substitution

Full direct substitution of hydroelectric power for oil and gas to be produced from the East Texas sale would not be possible since at least 50% of the oil is for transportation, a use which cannot be supplied by hydropower. However, refinery yields of products, overall, could readily be modified to accommodate this substitution. Other considerations restrict the feasibility of this alternative. The reliability of hydropower is limited by its seasonality. Furthermore, few dams are built solely for hydroelectric power generation. Irrigation, navigation, municipal and industrial uses, and flood control are important, and frequently are the dominant uses which may not be fully compatible with power production needs.

d. Environmental Impact

A number of environmental impact statements filed by the Bureau of Reclamation of the Department of the Interior and by the Corps of Engineers describe environmental impacts of specific hydroelectric projects.

Hydroelectric power produces no air pollution, radioactivity, waste heat, nor water pollution (with the exception of the loss of oxygen content in storage facilities). Dams valuable for hydroelectric purposes may be otherwise useful for such needs as irrigation and flood control. Lakes behind dams created for hydroelectric purposes provide recreational opportunities such as swimming, fishing and boating.

However, construction of a hydroelectric dam represents an irretrievable commitment of the land resources beneath the dam and lake, precluding other uses (agriculture, minerals, wildlife habitat, free-flowing river recreation, and so forth). Alteration of river flows may lead to silting behind the dam, thus progressively reducing reservoir capacity and its effective use and finally, after many years, filling the lake. Alteration of downstream flows from power-plant discharges can cause scouring of banks and bottoms.

Fish and wildlife habitat may be significantly changed. The reproductive habitats of anadromous fish may be severely altered by dam construction, unless elaborate provision is made for fish ladders or other means to provide safe fish passage.

6. Modification of FPC Natural Gas Pricing

a. Description of the Alternative

Natural gas in interstate commerce in the United States is under FPC jurisdiction. Under this alternative FPC would permit interstate gas prices to rise to the extent needed to attract additional investment in domestic oil and gas exploration and development, onshore and offshore, to provide sufficient additional supplies of natural gas.

In 1954, the Supreme Court ruled that independent producers of natural gas, whose sale of gas goes into interstate commerce, were not exempted from regulations under the Natural Gas Act. Since then, terms of interstate gas sales, including pricing, have been subject to Federal regulation.

In 1960 the FPC departed from an individual company "cost-of-service" method price determination in favor of an "area rate" concept.

The area rate method which has been upheld by the Supreme Court, involves the accumulation of data sufficient to determine the average unit costs associated with all aspects of natural gas production on an areal basis, instead of examining the costs of each producing company.

Recently, the FPC has modified its pricing policies to be more responsive to the current gas supply situation. Some FPC area price ceilings were raised about 35% during 1968-70, and still more recently the Commission has initiated major actions to stimulate natural gas exploration and development.

On July 16, 1971, FPC Opinion No. 598 set new, higher ceiling rates for the South Louisiana area and provided for a system of incentives to promote dedication of gas reserves to the interstate market. In support of its price action, the Commission observed that demand for gas as a "pollution-free fuel" is increasing and the price of alternative fuels is going up. It further concluded that there is "a worsening gap between supply and demand, and that price must have a major responsibility for eliciting new supplies."

Similar higher ceiling prices were later granted in other major gas producing areas.

In furtherance of the concept of providing incentives, the Federal Power Commission in Order No. 455 dated August 3, 1972, offered an optional procedure for certificating new producer sales of natural gas. Under this option, sales of new gas at prices above existing ceilings, agreed upon by buyer and seller, may be certificated subject to certain constraints and possible future actions by the Commission. This alternate procedure is designed to assure interstate gas consumers, and the nation as a whole, an adequate and reliable supply of natural gas at the lowest reasonable cost. It is not intended to replace geographical area pricing, but rather to provide an alternative procedure for certification of natural gas sales for new gas sales at rates above established area ceilings.

On November 8 and 9, 1972, the FPC issued notices of proposed rulemakings in Docket Nos. R-458 and R-459 respectively. The first proposed

a new policy under which it would consider applications by independent producers for special relief from area rate ceilings with respect to sales from reservoirs where reduced pressures, a need for reconditioning wells or deeper drilling render further production uneconomic at existing prices. The second recent proposed rulemaking in Docket Nos. R-459 would give special rate relief to producers in order to encourage the recovery of gas presently being flared or vented.

An additional policy enacted by the Commission to elicit increased gas supplies, though not price-related, concerns advance payments to provide for rate base treatment of advances made by pipelines to suppliers of gas to be delivered at a future date. That policy has been affirmed after court review. Advance payments for exploration and lease acquisition were excluded from rate base treatment by Order No. 441, dated November 10, 1971, but the Commission is re-evaluating that part of its policy. As of October 1, 1972, about \$1.25 billion in such payments had been committed by interstate pipelines. In the December 1970 Louisiana Gulf Coast area offshore lease sale, about \$300 million of the \$846 million in bonus bids was supplied by pipelines.

The Commission has also taken many other steps to mitigate the shortage of gas, including Order No. 402, concerning emergency gas sales, and implementation of a National Gas Survey to provide data for long-range planning.

Thus, since the FPC has modified its pricing to be more responsive to the supply situation, short of deregulation, it appears that this alternative has been implemented. In addition, since the FPC had full knowledge of and supported Interior's intentions regarding the proposed OCS lease sale, it is reasonable to assume that FPC price actions taken to date were not intended as an alternative to the proposed sale.

b. Incremental Production

In order to replace the amount of oil and gas expected to be produced from the proposed sale, the equivalent of an additional 780 to 1115 million cubic feet of gas per day would have to be stimulated through higher prices.

Several studies have been made on gas price - supply elasticity, all showing gas supply responding to price. Differences exist in the amount of increase in price and the corresponding increase in volume, but results indicate that a significant increase in price could offset the equivalent production from the proposed OCS lease sale.

Actual natural gas supply elasticity can only be determined by actual experience. Uncertainties involving investment responses and discovery rates inhibit meaningful projections of price/production relationships. While the incremental prices relevant to this specific proposed sale may be relatively small, it must be noted that the size of the required price increase would be related to the quality

of available oil and gas exploration prospects. If this and subsequent offshore lease sales are not held to make prime prospects available, requisite prices will be higher than if the offshore leases were made available for leasing.

c. Technological Feasibility of Substitution

Of the additional 780 to 1115 million cubic feet of gas equivalent per day that would have to be produced as a result of the implementation of this alternative, 30 to 65 million cubic feet a day would have to substitute for the oil that is expected to be produced per day as a result of the sale. As some incremental oil production may result as a by-product of increased gas exploration, the actual required substitution of gas for oil could be somewhat less than 30 to 65 million cubic feet a day. In any event the substitution of gas for oil is small enough, relative to total oil usage, that it could be accommodated through changes in oil product yields at refineries.

d. Environmental Impact

Specific environmental impacts are not listed in this section because the environmental impact of increased production from onshore and offshore areas discussed elsewhere, are applicable to this proposed action.

Since natural gas is the least polluting of the fossil fuels at the point of combustion, this alternative would benefit the environment to the extent that gas would be substituted for oil.

To the extent onshore gas production in the lower 48 states would be increased, it would reduce the need for gas from the OCS.

However, many of the remaining areas thought to have significant gas potential are offshore, so that additional production of gas in meaningful quantities would give rise to environmental problems essentially like those of OCS leases.

e. Health and Safety

The effects on health and safety of increasing onshore supplies can be found in the section dealing with increasing onshore production as an alternative to OCS leasing. The health and safety aspect of increasing offshore production as a result of modification of FPC pricing is essentially the same as the health and safety aspect of OCS production discussed in this statement.

7. Oil Shale Production

a. Description of the Alternative

Large areas of the United States are known to contain oil shale deposits but those in the States of Colorado, Utah and Wyoming are of greatest potential for commercial shale-oil production. It is estimated that some 73 percent of oil shale lands containing nearly 80 percent of the shale oil is on public lands. The highest grade deposits occur over an area of 17,000 square miles (11 million acres) and contain an estimated 600 billion barrels of oil. Recovery of even a small fraction of this resource would provide significant amounts of clean energy adequate to supplement the Nation's oil supply for many decades.

Three retorting processes have been developed to the point of technological practicability, but none has been demonstrated and tested at a commercial production scale. The mining of the shale presents no particularly difficult technological problems as it can be done by conventional room and pillar underground mining or by surface mining techniques. The major process barriers to development of this alternative therefore are the need for full-scale demonstration and testing to prove the technology and develop necessary cost and other data for determining economic feasibility.

On June 29, 1971, the Secretary of the Interior announced plans for a proposed prototype oil shale leasing program which is designed

to ". . . provide a new source of energy for this Nation by stimulating the timely development of commercial oil shale development by private enterprise, and to do so in a manner that will assure the minimum possible impact on the present environment while providing for the future restoration of the immediate and surrounding area." The proposed program would make available to private enterprise, for development under lease, a limited amount of public oil shale resources. Such leases would be by competitive bonus bidding and would include assumption of certain royalty obligations to the United States.

The proposed program is in concert with the President's Energy Message of June 4, 1971, in which he requested the Secretary of the Interior to initiate "A leasing program to develop our vast oil shale resources, provided that environmental questions can be resolved." The environmental question has come under intensive review over the past 3 years and, in September, 1972, the Secretary released a 1,300-page draft environmental statement. 1/ That statement details the proposed program and assesses the specific impacts expected from prototype development plus development on private lands that may be stimulated by the Department's action should the program be implemented.

1/ "Draft Environmental Statement for the Proposed Prototype Oil Shale Leasing Program", released September 7, 1972 by the U. S. Department of the Interior in three volumes.

b. Incremental Production

The proposed prototype program depends on industry as to the timing of commercial production. It is not possible therefore, to determine the exact amount of oil that is to be expected in the future. For planning purposes, however, it is necessary to determine the maximum rate of development that may be expected. This was done for the Department's study 1/ and the estimates are quoted as follows:

Commercial shale-oil production, under the most optimistic estimate, could begin about 1975 at a rate of about 18 million barrels per year (50,000 barrels per day), on the basis of anticipated technologic progress. The first generation technology needed for this rate of production would be improved from 1976 to 1980. This development stage will be reflected by only small increases in annual production of about 18 million barrels per year as the new technology is applied. By 1980 a productive capacity of more than 100 million barrels per year (300,000 barrels per day) could be established. More importantly, the technology probably will have been advanced to the point where large incremental increases in production could be achieved. Also, the nucleus of people, supporting

1/ "Draft Environmental Statement for the Proposed Prototype Oil Shale Leasing Program", released September 7, 1972 by the U. S. Department of the Interior in three volumes.

services, facilities, and experience needed for this expanded effort will have been established.

After 1980 the second generation extraction-retorting systems would be expected to permit annual additions to shale-oil productive capacity of about 37 to 73 million barrels per year (100,000 to 200,000 barrels per day). The rate at which oil shale may be developed provides the framework for subsequent calculations of the capital investments that will probably be required. Seven installations with a cumulative capacity of 400,000 barrels per day are assumed to be constructed on both private and public lands in the period 1973 to 1981. In the period 1981 to 1985 capacity is assumed to grow to one million barrels per day.

The cumulative 6-plant capacity of 300,000 barrels per day by 1979 reflects the necessary construction and evaluation phase of this new technologic development. Second generation technology could be expected to be available by 1980, enabling the large increases in capacity from surface processing systems. In-situ retorting may also be advanced to the point where the first commercial operation could be initiated. By 1985 cumulative capacity is estimated at 1 million barrels per day from both private and public lands.

Production of about 138,000-198,000 barrels per day of shale oil would be needed by 1980 to replace the energy expected from the oil and gas from the East Texas sale. Since development is now only in the pilot plant stage, oil shale will not be available in significant quantities before 1980 due to the lead time required to scale up prototype technology to commercial operations.

Two major options are being considered for oil shale development :

(1) mining followed by surface processing of the oil shale and shale-oil; and (2) in-situ (or in place) processing. Of the two options, only the mining-surface processing approach is believed to have been advanced to the point where it may be possible to scale-up to commercial production in this decade. In-situ processing is in the experimental phase and commercial application of this technique cannot be expected prior to 1980. The relative state of knowledge of the various operations required in oil shale processing is shown in Figure 7-1. 1/ It is apparent from Figure 7-1, however, that various technical approaches are available for each phase of the operations, and no single system is likely to dominate the initial development of oil shale.

1/ Most of the refining operations shown in Figure 7-1 would be performed outside of the oil shale region at refinery centers near markets for the products.

Until recent years, virtually all efforts to develop oil shale technology were directed toward mining, crushing, and above-ground retorting. Oil shale processing in this manner would require the handling of large amounts of materials. Figure 7-2 indicates the materials flow through such an operation, beginning with mining and ending with final fuel products and various by-products. In certain locations, the oil shale deposits contain minerals that may be amenable to recovery of additional by-products such as soda ash and alumina.

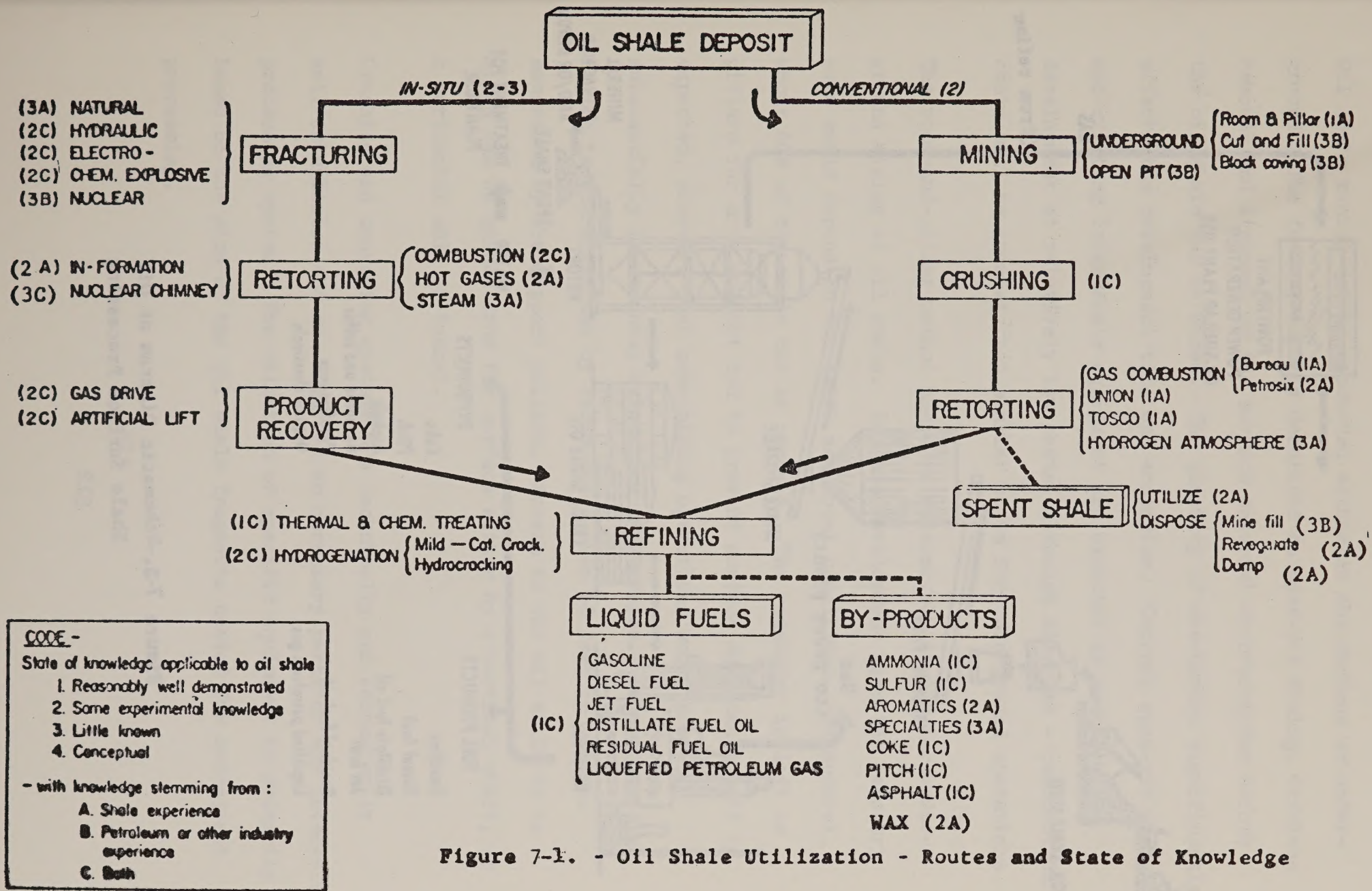


Figure 7-1. - Oil Shale Utilization - Routes and State of Knowledge

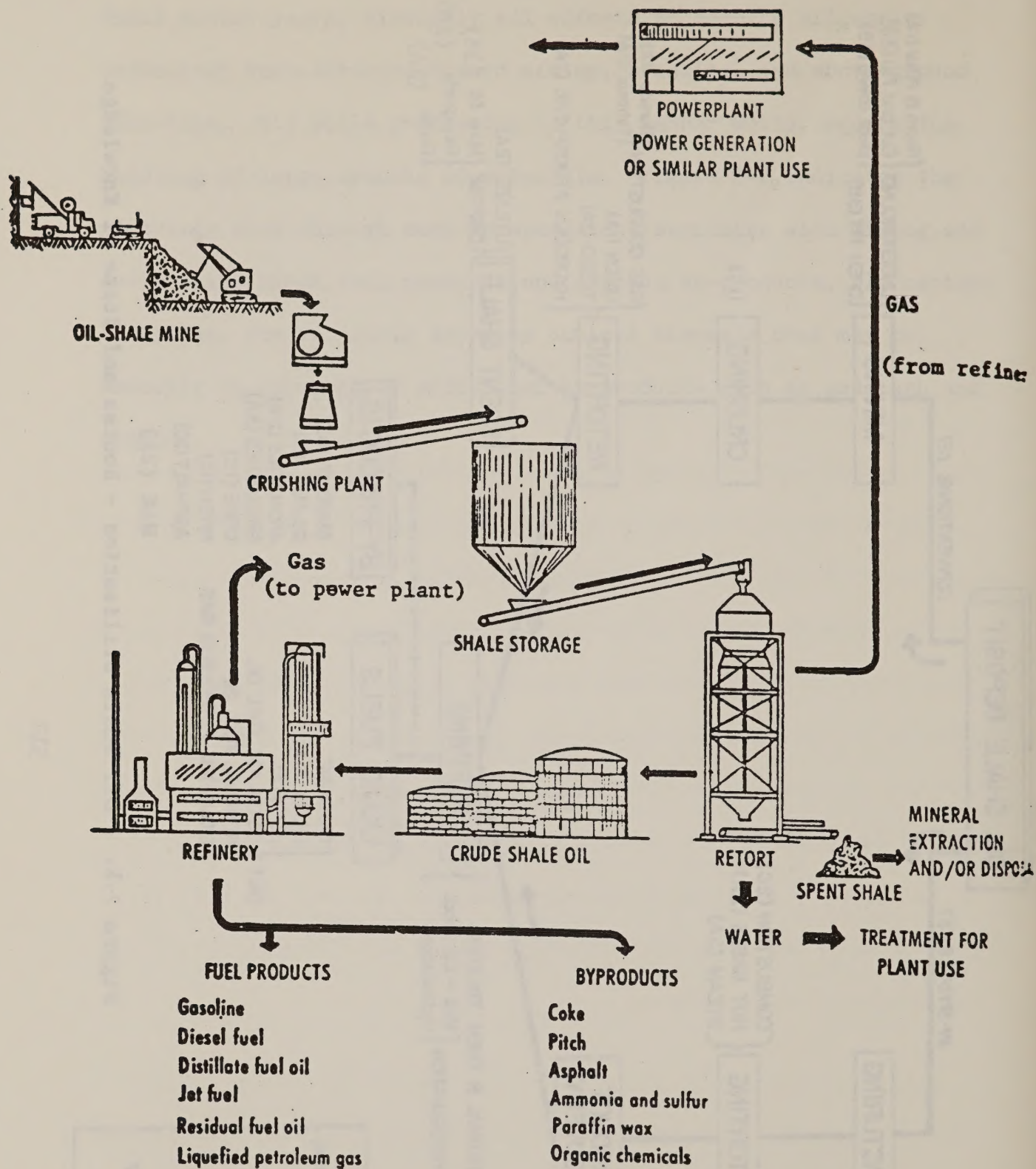


Figure 7-2.-Schematic Diagram of Oil Shale Surface Processing

Oil shale mining can be conducted either at the surface or underground. The former, usually described as open-pit mining, involves removal and disposal of the surface material or overburden before the oil shale can be mined. The quantity of overburden significantly affects the development time and economics. Current open-pit techniques and existing large-scale equipment are expected to enable mine development at relatively low costs, although disposal - restoration costs will be greater than similar costs for underground operations.

The room-and-pillar method has been extensively tested for underground mining of oil shale. In this development plan the recovery rate would depend on the depth and local conditions. In general, about 60% of the shale can be removed. The remainder is left as pillars for mine support and to prevent surface subsidence. It is expected, however, that some mining operations would provide substantially lower total extraction percentages. Room-and-pillar mining is characterized by large rooms over 60 feet in height, separated by the support pillars. Access to the oil shale to be mined can be gained from the surface either by a vertical shaft, or a horizontal adit or tunnel.

Crushing and conveying systems are technically and economically well-established and are regarded as necessary parts of any integrated processing system. The selection of specific equipment is primarily based on the size of the oil shale fragments needed for subsequent processing.

Literally thousands of retorting processes have been patented worldwide for the production of oil from oil shale. Three processes that have been tested using large experimental equipment appear at this time to offer reasonable possibilities of technical and economic success if scaled up to commercial design size. These retorting methods include the Gas-Combustion process developed by the Bureau of Mines, the Oil Shale Corporation (TOSCO) process, and the Union Oil Company process. In each system, heat is applied to raise the temperature of the oil shale to about 900 degrees F., where the solid organic material (kerogen) is converted to a liquid. The equipment, method of heat application, and operating procedures differ markedly for each system.

Oils from the retorting processes, with the possible exception of the TOSCO process, will require upgrading before the oil can be transported through pipelines to the final product refineries, which are expected to be located outside of the oil shale region. Modern refinery processes are suitable for subsequent upgrading. Each of the three retorts also produces a retort gas that may be used within the plant as a fuel, or alternatively, to generate supplemental electrical power for nearby communities.

Spent shale may be in the form of solid particles ranging from 10 inches in diameter to a fine powder, depending on the retorting

method used. It will normally be dry, but it may be wet if it is processed to recover saline minerals. Disposal will therefore depend on the physical characteristics of the material, its water content, and the location of the disposal area, whether surface or subsurface. If it is to be returned to the mine, this will affect the mine development plans.

Various processes for recovery of the saline minerals associated with the oil shales have been proposed.

The economical recovery of alumina, soda ash, and nahcolite (potentially valuable for removal of sulphur oxides from stack gases) from the deep oil shales has not yet been demonstrated on a large scale nor have the effects of their recovery been tested by current markets for these chemicals.

An alternate mining and processing technique would involve the recovery of oil from the shale by heating underground, in place. This technique is called in-situ processing and has not been successfully developed or demonstrated on a large scale, although considerable laboratory and field research has been carried out by government and industry.

Presently proposed heat sources for in-situ recovery include underground combustion, hot natural gas, hot carbon dioxide, superheated steam, hot solvents, and combinations of two or more of these. It

is anticipated that conduits for introducing heat underground would be provided by wells, mine shafts and tunnels, fractures created by a variety of techniques, or by a combination of these.

A commercial in-situ processing system has not been demonstrated to date, nor are there any indications that this is a viable technical option in this decade.

c. Environmental Impact

Oil shale development would produce both direct and indirect changes in the environment of the oil shale region in each of the three states where commercial quantities of oil shale resources exist. Many of the environmental changes would be of local significance while others would be of an expanding nature and have cumulative impact. These major regional changes would conflict with other physical resources and uses of the land and water. Impacts would include those on the land itself, the water and air quality, on fish and wildlife habitat, on grazing and agricultural activities, on recreation and aesthetic values, and on the existing social and economic patterns as well as other impacts. The Department's draft environmental statement 1/ has detailed these impacts from both prototype development and a mature industry. The discussion that follows is taken from Volume 1, Chapter V of that analysis.

1/ "Draft Environmental Statement for the Proposed Prototype Oil Shale Leasing Program", September 7, 1972, U. S. Department of the Interior.

The development of an oil shale industry would require roads, mining, plant sites, waste-disposal areas, utility and pipeline corridors, and associated services during the productive life of a lease. These activities would change the existing pattern of land use and alter the existing topography. Such disturbances would unavoidably exist throughout the life of operations, but would be temporary in the sense that restoration of surfaces to original or improved condition would be required before site abandonment. The cumulative land under development or otherwise not usable would be about 4,000 acres for a 200,000 barrels per day production. Land effects will vary depending on the mining and processing systems that may be used.

Waste disposal areas are generally considered to be in canyon and gully areas which would gradually be converted into flatter areas. Contouring and revegetation would restore scenic attractiveness and probably reduce erosion from the area.

These changes in topography would alter the appearance of the land and would affect natural vegetative cover until revegetation operations began. These changes would be adverse, in the sense that the area's present topography and semi-remote character would be altered. The degree to which these topographical changes are adverse, however, is a value judgment difficult to quantify. With proper restoration methods the scenic impact could be kept within acceptable limits. The actual impact would depend on the specific sites that may be chosen for disposal.

Where parts of any lease site areas are now used for livestock grazing, agriculture, wildlife habitat, or recreation, some unavoidable changes in land use patterns would result.

The total impact would be significant in local areas but slight for the region as a whole because the percentage of the region's total surface area affected by development (including urbanization) would be small. However, some local dislocations would unavoidably occur. The extent to which any changes in land use patterns would be adverse are discussed in the sections to follow, together with potential adverse effects on water and air resources.

In order to insure dependable supplies of water from the Colorado River or its tributaries, dams and reservoirs must be constructed, or water must be purchased from existing reservoirs.

The water diverted for all uses would have an unavoidable impact on regional water supplies, because any storage, diversion and net consumption of existing water resources would deplete natural stream-flow. This in turn would increase the salinity concentration of the Colorado River at Hoover Dam approximately 2 mg/l, about 0.5 percent above existing (1971) levels. Other salinity influences could occur from accidental releases, surface water runoff, and water table depression.

During the period between disturbance of the surface and revegetation, high intensity rains could cause accelerated soil erosion and channel cutting and could increase sedimentation in the stream beds. The

cumulative impact of this over time would be quantifiable by sediment measurements of the major rivers. Water discharged into the streams could add to the erosion factor and sediment load.

Drainage courses and channels would probably be diverted because of mine facilities and waste disposal areas. The quantity of impact depends upon the type and intensity of mining operations and control measures used.

As oil shale development proceeds, increased population in all areas would put a greatly increased sanitary waste load on regional water supplies. However, treatment and disposal facilities will mitigate adverse effects.

The disturbance of ground water by mining operations, or by water used to return spent shale underground for disposal, could have an adverse effect on subsurface water quality, ground water movement, water levels, spring flow, and streamflow. Knowledge of aquifer characteristics, head relations, and chemical quality distribution in the aquifers in much of the region is inadequate and the extent of this impact cannot be quantified. Specific information developed during core drilling, close monitoring of the quality of ground water, and prompt action to change operations detrimental to water quality would help mitigate adverse effects.

Proper techniques already exist to adequately control emissions, including particulates, sulfur oxides, and nitrogen oxides potentially present in various fuel gases, and the dusts produced in mining and shale disposal.

It is expected that all applicable Federal and State criteria on acceptable air quality standards could be met. Residual concentrations of sulfur dioxide, on the basis a 200,000 bbl/day output, would total 12 to 40 tons per day depending on the process and nitrogen oxides would total 17 to 23 tons per day. Solid particulates in gaseous discharges to the atmosphere would be small, but unavoidable for the program at the present state of technology. New control techniques now being developed for other industrial operations could be incorporated into this industry, which is at least 2, and possibly 4 years from construction. Some local problems with temperature inversion may be experienced, the significance of which cannot now be established. The long term effect of industrialization would result in a decline in general air quality of the region.

The local noise level at and near the selected sites is expected to increase, due to the mining, retorting, and other processing operations. This is an unavoidable adverse consequence of the increased industrial activity in a region which is presently predominantly a semi-wilderness, and can be only partially mitigated by noise abatement devices.

Construction and operation would have varying degrees of direct and indirect impacts upon fish and wildlife and their habitat in the immediate vicinity of the plants and along their appurtenant roads, surface facilities, and pipelines. Noise and associated human activities accompanying construction and operation would have a new effect of stress and disturbance on normal behavior and activity patterns of wildlife. Depending upon lease site characteristics, species which would be affected by such disturbances include mountain lion, bear, elk, mule deer, antelope, bob cats, sage grouse, blue grouse, and migratory birds. Animal species such as mountain lions, elk, and peregrine and prairie falcons, would be intolerant and areas of up 4,000 acres per year would be completely lost to them as habitat.

Air strips and increases in air traffic would provide some source of aerial harassment of mule deer, wild horses, and big game, the extent of which would be dependent upon the number and location of air strips and the volume of air traffic which would be involved.

Wildlife food and cover values of lands used for mining, pipeline and road construction, building, etc., would be at least temporarily lost. Permanence of such losses would be dependent upon the time required for and success of reestablishing useful wildlife food and cover. Such habitat loss would in turn result in lower populations of

animals. For example, removal of critical winter browse would result in a corresponding reduction in mule deer numbers.

Oil shale-related drying of surface water features, such as springs, seeps, and small streams, would change the natural plant-animal complex associated with each particular water feature, including the related distribution of game, wild horses and cattle.

Coverage of roadside vegetation with vehicle-caused dust would constitute a minor but chronic problem, since such vegetation would lose its wildlife food value until washed off by subsequent rains.

Unpredicted or uncontrollable changes in the quality of local surface or ground water would result in accompanying impacts on aquatic fish and wildlife populations and their habitat. In the event that sediment, leached substances, saline ground waters and/or toxic materials were released to surface waters as a result of oil shale operations, adverse impacts would be imparted to aquatic plants and animals. Unless carefully controlled, such discharges would have adverse effects on aquatic habitat of the Colorado, Green and White Rivers and other exposed water areas. Adverse impacts would also be expected in exposed aquatic habitat in the form of lowered biological productivity, physical covering of fish spawning and nursery areas.

Handling, storage, and transmission, including feeder pipelines, would exhibit some small losses of oil. Spills would follow natural drainage features and released oil would result in mortality to trees, shrubs, and other vegetation with which it came into contact. Birds, some species of both land and water mammals, and fish and other aquatic organisms would be adversely affected if they came in contact with the oil.

Oil shale-related urbanization would also result in some regional adverse impacts upon fish and wildlife and their habitat. Facilitated access and increasing human habitation and activities would result in a region-wide disturbance and stress on wildlife populations. Reductions in surface water quality would occur near population centers, as a result of sewage, toxic substances and siltation and such reductions would have adverse impact upon aquatic organisms and their habitat. Some wildlife habitat would be consumed by buildings, roads, parking lots, etc. Additional wind and water erosion would occur. Increased ground vehicle traffic would result in more frequent road kills of deer and other game.

Increased hunting pressure would cause localized adverse impacts upon wildlife through reduction of populations of some species. Increased harvest of mule deer, elk, moose and antelope would require regulation in order to avoid undesirable downward popula-

tion trends. Region-wide increased hunting pressure would have the most potential for further reductions in very low abundance species, such as brown bear and cougar.

A predictable decrease in the quality of both fishing and hunting experience would occur wherever intensified use resulted in fewer and/or smaller fish and game and the physical presence of more hunters or fishermen. One significant effect of a regional oil shale industry would be the net loss of semi-remote hunting and fishing qualities, caused by visual and audio effects of road, vehicular traffic, and other industrial urban factors.

Both development and associated urbanization would contribute to those factors which have resulted in the rare and endangered status of several species. If impoundments were constructed on the fast water streams hosting the humpback chub and Colorado River squaw fish, the presently limited habitat of these species would be further reduced.

A 200,000-barrel per day oil shale industry would affect annually about 4,000 acres undergoing mining disposal, and restoration, 3,000 to 4,000 acres for human use (residential, etc.) and 340 to

400 acres for utilities. Based on 30 years of operation, and 4,000 acres affected, these activities would result in a temporary loss of 9 AUM's 1/ per year and a loss for the duration of 35 AUM's per year. This is assuming that land used for off-site requirements is largely unavailable for grazing or unsuitable. However, the pipeline corridors are unavailable only temporarily. After revegetation, forage is normally equal to or better than before. On the other hand, the changes in life styles or other factors could lead some present livestock operators to reduce ranching activities or cease entirely. While this might not affect actual forage production, it would reduce utilization and effective production of beef.

The new roads, trails, plant sites, waste disposal areas, utility and pipeline corridors which would be part of the prototype oil shale industry would affect the appearance of the present landscape. This is also true of the mining operations, whether underground or on the surface, and applies to in-situ processing as well. The extent of these changes has been reviewed above. The extent to which such alterations in topography could be considered aesthetically adverse is a matter of personal judgment which is difficult to assess quantitatively.

1/ An Animal Unit Month (AUM) is the amount of natural or cultivated feed necessary for the sustenance of one cow or its equivalent for a period of one month (43 CFR 4110.0-5(0)).

Vegetative rehabilitation success is dependent upon soil quality, water availability, nutrients, and plant vigor. Rarely is the re-established vegetation on disturbed sites as productive or as suitable to wildlife species as the endemic food and cover plants, especially the aspect related to cover and seasonal nutrition values; therefore, long-term reduction in value of the wildlife habitat, and attending recreational opportunity on all seriously disturbed development areas could be expected. Also, during the period between disturbance of the surface and revegetation, high density rains could cause accelerated soil erosion and channel cutting, and could produce increased sedimentation in stream beds, especially those of the free flowing Piceance Creek and White River. Such siltation would have an adverse effect on fishing opportunities and other associated water oriented recreation activities. These adverse impacts can be minimized by enforcement of stipulations that will be incorporated into oil shale leases.

Although there are no known historical or archaeological sites on any of the selected tracts, it is a reasonable assumption that the sites or the general area was formerly inhabited by nomadic, hunting, Indian tribes. Any disturbance of the surface, especially an open pit mining operation, could possibly disturb some unknown historic archaeological site or artifacts. However, such activities would also increase the probability that such items would be located.

The increased urbanization of a region which is primarily rural, would be an unavoidable consequence of the oil shale development. Since the benefits and costs of urbanized life versus rural life are a matter of personal value judgment, it is impossible to assess the degree to which the social environmental impact would be detrimental. To the degree that urbanization provides diversity of opportunity and choice, the new social changes could be considered beneficial.

8. Wellbore Stimulation for Recovery from Known Deposits

a. Description of the Alternative

Formation "acidizing" and "fracturing" methods are commonly applied in oil and gas wells to stimulate recovery from tight formations and mature fields. Because such wellbore stimulation methods, as conventionally applied, have become an accepted part of producing practices, they cannot be regarded as offering an alternative way of achieving new production.

One innovative method, nuclear stimulation, does have the potential to add materially to the nation's recoverable gas reserves. This method would use nuclear explosives to fracture low permeability gas reservoirs otherwise incapable of sustaining commercial flow rates.

Current emphasis in the U. S. Atomic Energy Commission's Plowshare program is to develop the technology for applying the effects of nuclear explosions to the recovery and utilization of natural resources, primarily natural gas. The program plan is to continue the design and testing of the nuclear explosive, and to assess by field tests techniques for utilizing the effects of multiple nuclear explosives to recover natural gas locked in tight geological formations. Such gas cannot now be economically produced by conventional methods. Most reserves lie in thick, deep reservoirs of very low natural permeability, geographically situated in the Rocky Mountain Belt.

Projects Gasbuggy and Rulison are essentially pilot experiments involving the detonation of a single nuclear explosive. Both of these projects are clearly demonstrating that recovery of natural gas by nuclear explosion stimulation is technically feasible and economically promising. The next development phase involves techniques for using multiple explosives in a single wellbore. Gas formations amenable to nuclear explosion stimulation are thicker than can be effectively and feasibly stimulated by a single explosion.

The Atomic Energy Commission has recently reported on the possible scope of nuclear stimulation, and has provided an economic assessment of the technical programs needed to achieve commercially viable application of nuclear stimulation of natural gas wells.

The AEC concluded that, based on certain assumptions, "over 10 percent of the Nation's current gas consumption could be met by gas from nuclear stimulation by a development rate of about 50 wells per year". The report indicates, however, that it would take approximately 20 years before gas produced from stimulated reservoirs would be about equal to 10 percent of 1969 consumption. To accomplish this level of production it would be necessary to explode 4,000 nuclear devices of 100-kilotons each in 1,000 wells over the 20 years.

Most natural gas resources amenable to nuclear stimulation are located in the Rocky Mountain region where approximately 300

trillion cubic feet of gas is estimated to be potentially recoverable using modern technology.

The current development program rate is not expected to provide, in the next ten years, quantities of natural gas that would be meaningful in comparison with present sources of supply.

b. Incremental Production

Assuming successful development of the technology, the AEC estimates that nuclear stimulation could add some 1 trillion or more cubic feet of natural gas to U. S. production per year beginning in the late 1970's or early 1980's.

c. Technological Feasibility of Substitutions

To the extent that natural gas could displace crude oil demand, this method might be considered a partial alternative to OCS development. It is not now considered a practical alternative because the commercial technology remains to be developed. Several years of development work need to be carried out before the nuclear stimulation technology will be available for commercial applications.

d. Environmental Impact

The AEC's Plowshare program to increase natural gas production from tight reservoirs could conceivably affect the environment in two ways. The first, and potentially most damaging, would come from radioactivity. Secondly, seismic disturbances resulting from the explosions could also have an adverse effect.

Both these potential problems concern the surface or subsurface, leaving atmospheric contamination or disturbance unlikely.

Most radioactivity produced by the explosives will remain underground trapped in the resolidified rock near the bottom of the chimney or attached to the rock surfaces in the chimney. Project design should take into account mobile waters and assure that chimneys remain isolated from them. The formations of interest for nuclear - explosive stimulations are generally at depths of 5,000 to 10,000 feet or deeper, have low permeability, and would not be expected to contain mobile water. Significant vertical communication with shallow water-bearing formations through existing or created faults or fractures could present a serious limitation. Water produced with the gas from nuclear - explosive stimulated wells will contain tritium. Control methods to dispose of this contaminant will have to be developed.

The chemical composition of the gas itself in each stimulated well is assumed to be similar to that measured in the first experiments. The initially large carbon dioxide concentration in the chimney would be reduced by dilution with pipeline gas or carbon dioxide would be removed by standard gas field practices. Gas production from the wells could be delayed until short-lived radionuclides decayed. Technical information from subsequent experiments will aid in defining the time for initiation of production.

The remaining gaseous isotopes--tritium and krypton-85--are calculated to provide less than one millirem per year of exposure to the general population if the gas were used as a part of the total gas supply to a large city. No insurmountable problem is anticipated in meeting future regulations or standards developed for sale of the gas. It should be emphasized that the environmental impact of using gas that contains small amounts of tritium will have to be weighed against not having the gas available to augment the Nation's energy sources.

The potential environmental impacts resulting from nuclear stimulation of a single well or in a small geographic area have been stated and evaluated in the environmental impact statements prepared for the proposed Phase I Rio Blanco 1/ and Wagon Wheel 2/ projects. Extrapolation of the impact to a full commercial development is related primarily to the frequency and size of explosives and to changes in local environment as the areas of development expand.

AEC's proposed schedule calls for drilling and firing 100 wells per year (for possibly 50 to 60 years). On the average this would involve approximately 370 explosive devices per year; usually 3 or

1/ Environmental Statement--Rio Blanco Gas Stimulation Project, U. S. Atomic Energy Commission, Washington, D. C., Dept. Wash. - 1519 (April 1972).

2/ Environmental Statement--Wagon Wheel Gas Stimulation Project, U. S. Atomic Energy Commission, Washington, D. C., Dept. Wash. - 1524 (April 1972).

4 explosives in each well. Spread uniformly over the year, simultaneous firing of the multiple explosive loads could result in local area disturbances as often as every nine days. This would have a substantial impact on wildlife and public residents and visitors. The seismic nuisance could be lessened by preparing several wells to be shot on the same day. The AEC estimates that four detonation days per year should suffice for the 30 to 40 wells to be completed for each field area.

The size of the explosive required to stimulate the very thick geologic sections and the actual seismic effect of such devices are still subject to speculation. Prior to full field development, this impact must be assessed and evaluated. Public inconvenience and repairable or negotiable damage must be compensated. Irreparable or non-negotiable impacts would deter development.

In extrapolating the projected or observed impact of test projects, consideration must be given to the total environment of the basin. The site for the Rio Blanco experiment, for example, is relatively isolated. There are thought to be no surface or subsurface structures or operations in the zone of substantial damage. The fact that this will not invariably be true is an important environmental consideration when planning commercial development.

By its nature, nuclear stimulation has a dramatically destructive effect on the natural-gas host rock. The fracture zone should extend 300 to 400 feet from the center of the explosion. Also the compression wave moving out from the explosion can cause spall near a free surface (ground level) or other faulting or fracturing in areas where there are relatively large directional stress concentrations. This leads to concern where there are other valuable mineral resources in the vicinity. There is an unusual complexity in discussing the potential effect on other mineral resources from nuclear stimulation of the natural-gas basins as an energy alternative since oil shale and associated sodium and aluminum-bearing minerals also represent major mineral resources in the basins which are known to exist for potential development.

Surface impact of nuclear stimulations on vegetation will largely result from road building to well sites, and from clearing of drill site areas for drilling and production operations. Drill site locations will return to natural conditions in a short period. This would be similar to conventional gas well drilling and production. The areas affected by natural gas stimulation will be quite small and no significant impact on productive use will occur.

The need for local services and materials will have relatively little affect during the first experiments, but as the field development program advances, the need will become greater. Long-

term employment associated with full field development could involve hundreds of direct gas industry employees. Current local sources of supplies and services would have to be substantially increased or supplemented. Since much of the work would be conducted year-round, undoubtedly there would be families moving to the areas, causing an increase in such community needs as schools and homes. Additional revenue would be forthcoming to the counties, as well as to the State and Federal Governments.

The development of nuclear stimulation of natural gas reservoirs may be accompanied by some possible damage to existing structures, due to ground motion. Damages would have to be repaired, or compensation rendered to owners. Ground motion is predictable and utmost care would be used to minimize this effect.

It has been suggested that residual stress from a number of detonations might accumulate and present an earthquake stimulation hazard not present in a single detonation. The best evidence available on this point is from experience with the Nevada Test Site, where data from seismic wave generation and from stimulated fault motion indicate that the cumulative effect of many explosions is to reduce ambient stress levels rather than to increase them. A recent series of high-precision geodolite measurements indicates, also, that the residual strain field around a single explosion site tends to relax

with time. In any case, observations of the seismic effects of a series of detonations would permit continuing appraisal of this issue. In the light of present information, it does not appear to constitute an adverse environmental impact.

Adverse environmental impacts for nuclear gas stimulations on a commercial scale should be small in comparison to the benefits to be obtained. Both oil and gas will be needed in increasing quantities in the future. The proposed project is supplemental to other means of increasing natural gas supply. Some quantities of natural gas that would meet clean fuel requirements could be made available in the 1975-1980 time frame if nuclear gas stimulation technology is vigorously pursued. The public acceptance questions involved in proposals for nuclear stimulation of natural gas reservoirs exceed expected technical problems.

e. Health and Safety

The production testing technique for current experiments involving initial flaring of gases containing low levels of radioactivity is not contemplated for commercial production. All produced gas is expected to be fed into commercial pipelines.

The depth of the gas formations of interest throughout the Rocky Mountain area is such that the probability of releasing any radiation to the atmosphere at detonation time is very low. Even so, every reasonable precaution would be taken during the field development program to prevent even a slight accidental seepage of radioactive gas to the atmosphere. If an unforeseen seepage of radiation were to occur, previously developed remedial plans would be initiated. Although radiation would not be expected to be detected, long and short-term radiation monitoring techniques would be employed during field development.

9. Increase LNG Imports

a. Description of the Alternative

Because of the more than 600:1 volume reduction which occurs when natural gas is liquefied, large volumes of natural gas in a liquefied form are relatively easy to transport and to store. Though natural gas 1/ (LNG) has been liquefied commercially since 1940, in the United States its use until recently has been on a small scale, primarily by gas utility companies for peak-shaving purposes.

Because of the growing shortage of domestic gas supplies, plans are now being made by the gas industry for large LNG imports under long-term contracts. Recently the FPC approved two projects which together call for deliveries of more than 1 billion cubic feet/day of LNG from Algeria. Algeria is currently providing baseload quantities of LNG to England and France.

The following table presents FPC staff's projections of LNG imports to 1980. These figures are based on the assumption that all the projects which have been filed with the FPC, as well as those which have been tentatively proposed by industry, will be in full operation by 1980.

1/ Natural gas becomes a liquid at -259°F at atmospheric pressure.

LNG Imports 1/

<u>Year</u>	<u>Quantity MMCF/Day</u>
1975	800
1976	1,900
1977	2,700
1978	3,600
1979	4,700
1980	5,500

While foreign supplies of natural gas appear to be adequate to meet these requirements, it should be noted that much of U. S. imports of LNG will be from areas where political instability could impair the security of supplies. As with crude oil imports, increasing LNG imports could also have an unfavorable impact on balance of payments.

b. Incremental Production

If the proposed OCS sale is withdrawn and the expected production replaced by LNG, imports would have to increase in the range of 778 to 1,112 million cubic feet/day. This figure represents the expected gas production of 750 to 1,050 million cu. ft./ day, plus 28 to 62 million cu. ft./day to substitute for the expected oil production. An increase in imports of this amount would require one additional LNG tanker receipt each 2 to 3 days. Thus by 1979, when

1/ Federal Power Commission, Bureau of Natural Gas "National Gas Supply and Demand 1971-1990, Staff Report #2 P. 70.

production from this sale should be on-stream, LNG imports will have to increase above the projected levels by 17% to 24%.

LNG imports to substitute for this sale would require an increase in either the size or number of regasification plants now being proposed and in the number of LNG tankers. Since an LNG project requires a lead time of about six years, planning should begin at the same time that the sale would have been held.

Estimating the cost of this increase in LNG imports is difficult at this point in the development of the program. One way to arrive at an idea of the costs is to look at two projects recently approved by the FPC. A plant at Cove Point, Maryland, with the ability to produce 650 million cu. ft./day will require an initial investment of about 93 million dollars. An additional 89 million dollars will be required for the construction of pipeline. 1/ Another approved project will bring about 350 million cu. ft./day into Savannah, Georgia, and will require 63 million dollars for the plant facilities. This project also calls for 25 million dollars for pipelines. At full operation these two plants will import the equivalent of one billion cu. ft./day. The cost of the Algerian facilities will be about \$675 million. Although this cost is not currently borne by American companies, it becomes important in future projects. The companies involved have estimated that this level of imports would mean an

1/ All data taken from Federal Power Commission Docket No. CP 71-68.

investment of about 750 million dollars for LNG tankers. The increase in imports presented in this alternative would be close to the projected size of these projects. Further applications filed with the FPC indicate the costs in the Cove Point and Savannah projects may be significantly lower than for future projects. It would appear that if this alternative were selected to replace the sale, it could entail an investment of more than one billion dollars in plant and tanker facilities.

The price to the consumer of imported LNG is also difficult to project. The FPC, in approving the El Paso Natural Gas Co. application to import LNG, limited initial prices to 77¢ per million BTU's delivered to Cove Point, Md. and 83¢ at Savannah, Ga. The company has indicated that the allowed prices may be insufficient. Even if allowed LNG prices are not increased, LNG will be more costly in East Coast markets than the new gas expected from the proposed OCS sale. The current ceiling price for new gas in the offshore Louisiana area, under the area rate method, is 26¢/Mcf. Under the FPC's new optional pricing system the price of OCS gas could rise. The first applications under this policy have proposed to sell gas for 45¢/Mcf.

c. Technological Feasibility of Substitution

Increasing LNG imports to substitute for this sale would be technologically feasible. LNG processes are well developed.

LNG is regasified and distributed in regular natural gas pipeline systems.

d. Environmental Impact

One beneficial effect of this alternative would be the substitution of clean natural gas for oil. The quantity of oil however that would be replaced by LNG if the lease sale were not held would be extremely small when compared to the total projected domestic consumption of oil. It is doubtful, therefore, that this substitution will have a significant effect on the atmosphere. In the regasification of the LNG, gas or water will provide the heat for vaporizing the LNG and the release of significant pollutants into the air is not expected.

The construction of regasification plants will have an impact on land resources. The extent and duration of the impact will depend on the size and location of the plant. While there will be some disruption of the land surrounding the plant during construction, this disruption should be temporary if proper techniques are used. During construction there will be some damage to animal habitats. This damage will be permanent only in the area occupied by the plant and supporting facilities. Surrounding areas that may be damaged should return to a near-normal condition after construction is completed.

Existing pipelines will be used to transport regasified LNG, if they are available, but new pipelines will be required in some areas. The potential environmental impact due to pipeline construction is examined in the section of this statement dealing with the effect of increasing onshore U. S. gas production.

Each regasification plant will require facilities to permit the transfer of LNG from tankers to storage areas. In the Cove Point case, this will be accomplished by the construction of a mile-long pipeline into the Chesapeake Bay. At the proposed Savannah plant a channel and a turning basin would be dredged in the Savannah River to allow the tankers to come close to the plant. Both of these methods will require initial dredging, and possibly continued dredging, causing increased turbidity of the water and disruption of marine animals, especially in the case of bottom-dwelling organisms. In most cases this disruption would be temporary, but care would have to be taken to avoid, as much as possible, commercial fishing areas.

Since natural gas or water will be used to regasify the LNG, very few pollutants will be released into the nearby body of water. Plants using water to regasify the LNG will release the water at a lowered temperature. In the case of the Savannah plant, water temperature will be lowered 50°F in the vaporizer and then will be returned to

the river. This lower water temperature could be beneficial by allowing the water to hold more oxygen. The amount used and released, however, will be very small in comparison to total volume of water passing the plant.

A regasification plant could have an impact on the scenic and recreational resources of an area. The choice of the plant site is an important factor in minimizing the impact on scenic qualities and recreational activities. The increase in ship traffic could have an effect on water-oriented recreational activities.

e. Health and Safety

A major concern of any regasification project will be to insure that proper precautions are taken during the handling and storage of the LNG. An early LNG plant was destroyed by a disastrous fire in 1944 due to the failure of a storage tank, with a loss of more than one hundred lives. Many improvements have since been made in the technology of storage and handling of the LNG and increased attention has been given to proper safety precautions. The possibility of fire, however, must always be considered in the handling of LNG.

Studies on the possibilities of explosions resulting from LNG spills are inconclusive. Bureau of Mines tests indicate that under certain conditions small-scale explosions result when the LNG is poured onto

water. They are not able, however, to predict the result of a large-scale spill on open-water. Another study, by Shell Pipe Line Corporation, concluded that there was little danger of normal LNG exploding when spilled on water. They feel a vapor explosion could result only after the methane content of the LNG had reached 40%. Since the normal methane content of LNG is 80-90% or more and the boil-off rate is 0.2%-0.3% per day, it felt that with present day shipping practices a reduction to 40% is not possible. 1/ Worldwide experience to date in the handling and shipping of LNG has resulted in no serious explosion or fire. Since 1961, when commercial delivery of LNG by tanker began, there have not been any accidents at sea. However, there have been LNG spills reported in certain foreign countries but they have not been serious. Further discussions with the Bureau of Mines have indicated that an explosion resulting from an LNG spill in open water is unlikely.

Another hazard associated with LNG is the possibility of a major fire resulting from spillage or leakage in transportation, transfer and storage. Since spilled LNG would not vaporize instantaneously, the release of the equivalent of several million cubic feet of gas, for

1/ Tholief Enger, "Rapid Phase Transformation During LNG Spillage on Water", paper presented before The Third International Conference and Exhibition on Liquefied Natural Gas, September 1972.

example, might cause a fire which would continue until all the LNG had vaporized. The Bureau of Mines also reports that, if there were no fire, the concentration of natural gas in the area of the spill and downwind from the spill would be significantly higher than normal. Both of these factors could become significant if a major spill occurred near a heavily populated area.

References

- Bureau of Mines, USDI, "Hazards Associated with the Spillage of Liquefied Natural Gas on Water", RI 7448, November 1970.
- Bureau of Natural Gas, FPC, National Gas Supply and Demand 1971-1990 Staff Report, No. 2, 1972.
- Federal Power Commission, "Second Report on Liquefied Natural Gas", New Release No. 17816, October 18, 1971.
- Kahn, Amanullah R. and Bodle, William W., "Supplementing United States Gas Supplies with Imported LNG", Journal of Petroleum Technology, May, 1972, pp. 535-539.
- Koerner, William R., Jr., "Initial Brief of Commission Staff" FPC Docket Nos. CP71-68; CP71-153, CP71-290; CP71-151, CP71-264; CP71-276; CP71-289, August 16, 1971.
- Weatherwax, David E., et.al. "Initial Brief of Consolidated System LNG Company, "FPC Docket Nos. CP71-68; CP71-153, CP71-290; CP71-151; CP71-264, CP71-279; CP71-289; February 7, 1972.

10. Synthetic Natural Gas and Oil

a. Description of the Alternative

Through hydrogenation processes, it is possible to convert coal to various hydrocarbon liquid and gaseous substitutes for natural oil and gas. Considerable research and development has been done and further R & D is being conducted by the Federal Government and private industry. While many individual units for commercial gas processes have been tested, synthetic gas has not yet been proved economical in the United States. There are presently no coal-to-liquid conversion plants in the United States. The Department of the Interior's 1972 coal research report (USDI, Office of Coal Research, 1972), describes much of the work currently in progress.

The President, in his Clean Energy Message of June 4, 1971, and in subsequent messages, has given special attention to accelerating development of coal gasification.

The feasibility of producing synthetic natural gas and oil from coal as an alternative to the proposed lease sale depends upon the rates at which technological systems are developed, tested and proved economic and at which commercial scale plants are built. While it is possible that substantial amounts of synthetic fuels could be produced from coal by 1980-1985, the state of technology permits no accurate forecast.

Natural gas can also be synthesized from petroleum. Such gas has been produced commercially in Europe and some 25 plants are in the planning stage for the United States. While the gasification of oil does not add to overall energy supplies, it does provide an additional flexibility in energy form.

b. Coal Gasification

The need for natural gas has been discussed in the section relating to Federal Power Commission natural gas pricing policies. Because of its clean-burning characteristics, gas is the preferred fuel for use in small installations--such as for home heating--where economics preclude the installation of pollution control equipment.

In the event of limited gas supplies, steam-electric power plants will probably be the first to be denied the use of pipeline-quality gas. Coal can be converted to a clean, low-Btu gas for use under utility boilers. Although such synthetic gas can be piped short distances, it will be more economical to use it adjacent to the gasification plant.

While no coal to pipeline-gas process has yet reached commercial application in the United States, at least two companies plan to construct a commercial coal-gasification plant using the Lurgi process, which has been known for a number of years, and has been applied commercially in Europe. The earliest date for production from these

projects is 1976. Since gas produced by the Lurgi process has heating value of only 400-450 Btu/cf, catalytic methanation is required to achieve pipeline quality of 1000 Btu/cf for American gas utility use. This step has not yet been commercially demonstrated.

The Department of the Interior and the American Gas Association are cooperating on the accelerated program for coal gasification announced by President Nixon in his Clean Energy Message of June 4, 1971. Two coal gasification pilot plants have been built and are now undergoing shakedown operation, and a third plant has been authorized. In each of the plants a unique gasification method will be tried in conjunction with different systems of gas cleanup and methanation so that a final process, combining the best features of the individual processes, can be chosen by the summer of 1975. Construction of a demonstration plant is expected to follow so that a large-scale plant will be on stream by 1977.

Research over a period of fifteen years by the Bureau of Mines has culminated in the development of the "Synthane" process. In June 1971, a contract was let to Lummus for design of a pilot plant. A draft environmental statement (DES 72-3) was released January 24, 1972. Meanwhile, a smaller pilot plant will be operated by Hydrocarbon Research, Inc., under a contract with the Bureau. The Bureau also

has under review another coal gasification scheme, termed a modified Lurgi process, to use strongly caking coals for making a clean, low-Btu gas.

It will require about 5 million tons of coal a year to support one 250 billion Btu per day coal gasification plant (minimum commercial size). When full production is reached, the oil and natural gas expected from this sale should provide 803 billion to 1150 billion Btu's/day. Thus complete substitution by coal gasification would require 4-5 plants of the 250 billion Btu's per day size. This number of plants would require 24-30 million tons of coal per year and 4 to 5 mines. Estimates for the cost of a plant to process 250 million Btu's/day are about \$250 million including the coal mine. Recent estimates by the Office of Coal Research, and the Bureau of Mines, using utility type economics, project a selling price for the gas of about 85-95 cents per MM Btu at the plant. Revisions of these figures can be expected as pilot plant projects are evaluated and technology developed.

c. Oil Gasification

Synthetic natural gas (SNG) can also be produced from petroleum feedstocks. Processes that are being considered include:

1. Thermal cracking in steam.
2. Thermal cracking in a hydrogen-rich atmosphere.
3. Catalytic cracking in steam.
4. Partial oxidation.

Currently, much attention is being given to catalytic rich processes, developed by the British Gas Council. Called the CRG (Catalytic Rich Gas) process, it can gasify a wide variety of hydrocarbon feedstocks, though attention now is concentrated on naphtha feedstocks.

A CRG plant involves two basic operations:

1. Feed preparation, including fractionation and desulphurization.
2. The CRG process, per se, including gasification, and methanation to a gas with a heating value of 980 Btu per cubic foot.

Desulphurization of the feedstock is accomplished by mixing the feed with hydrogen-rich gas, vaporization, and treatment with nickel-molybdate and zinc oxide catalyst. If sulphur is to be recovered, the sulphur-rich fraction is hydrodesulphurized.

About 25 SNG projects, using naphtha feedstocks, have been announced. About half of these state that they intend to operate on imported naphtha. Estimated costs for SNG range from \$1.25 to \$1.75 per MM Btu.

The environmental impacts of such plants are expected to be less than those of comparable coal-based synthesis plants, because they would be free of ash and char, and sulphur oxides and particulates discharge problems.

d. Coal Liquefaction

Until recently, there has not been the same sense of urgency with reference to the conversion of coal to clean-burning oil as exists for pipeline gas. One reason is that imported oil has been available at cheaper prices than a synthetic crude. Also, environmental restraints have forced some electric utilities to abandon the use of coal, or to forego its use in new plants. The supply of low-sulphur coal in the East is limited, additional natural gas for electric utility use is not now available to householders and commercial users, electric utilities may soon be restricted or banned from using natural gas.

Accordingly, the supply problem relating to oil now is being viewed in a more urgent context. The situation, however, as regards the necessity for developing coal-to-oil technology is not yet escalated to an urgent program basis.

The Department of the Interior has filed a Final Environmental Statement, and will soon erect at Fort Lewis, Washington, a Solvent-Refined (SRC) pilot plant. Consideration is now being given to the conversion of Project Gasoline and the pilot plant at Cresap, West Virginia, to test a simplified version of the H-Coal process, and a Bureau of Mines coal conversion process along with others.

Because coal-to-gas, oil-to-gas, and coal-to-liquid fuel plants would be similar in most respects (boilers, reactors, gas scrubbers, etc.) the environmental impacts would be similar. The impacts of transporting these products to market via pipeline has been discussed in an earlier section. The environmental impacts of coal mining have also been discussed and will not be repeated here.

e. Potential Environmental Impact of the Alternatives

Like natural gas, synthetic (also called substitute) natural gas and oil from coal are clean-burning fuels because the sulphur has been reduced to very low values, and no particulate matter is emitted at the point of combustion.

Since there are ample reserves of coal in this country, conversion plants would afford a reliable supply of synthetic fuels for many years, thereby reducing dependence on imported oil and LNG, and concomitantly lessening the potential adverse environmental effect associated with shipping these fuels and delivering them in ports.

Owing to the fact that this report is general, and does not bear on a particular site in the United States, the importance and magnitude of the possible environmental impacts must be estimated. Obviously, the impacts will vary greatly with plant location.

On the basis of some limited pilot plant data, and knowledge of other industrial plants and complexes, some estimates can be made about the principal environmental impacts.

Site preparation and plant erection will have environmental effects, the kinds, importance, and magnitude of which will depend on the site that is selected. Consideration would be given to the effect on factors such as earth, water, flora, fauna, land use, recreation and aesthetics.

Plant operation, consisting of handling and transporting the coal to the process and converting the coal to gas and/or oil, will involve very large quantities of water for cooling and scrubbing gases, and very large quantities of devolatilized coal, called char, which will be burned in boilers to generate process steam and power, or gasified to make process hydrogen. Major emissions that must be controlled are:

1. Sulphur and nitrogen oxides, bottom ash and fly-ash from the plants generating process steam and power. Fly-ash emission from boiler stacks can be controlled, and furnace-bottom ash and slag are handled routinely without environmental problems. However, it may become desirable to locate large coal-conversion plants near large strip mines, where ash and slag from the process would be returned to the open cuts, and the ground restored in accordance with environmental considerations. The technology for controlling sulphur and nitrogen oxides from such plants will be available when the processes become commercial.

2. Contaminated water discharges containing phenols, cresols, benzene, oils, tars; and ammonia gaseous discharges from the Claus tail gas containing some hydrogen sulphide dioxide; and solid discharges such as char and ash; and possibly solids from gas-scrubbing systems using solid sorbents such as dolomite. Process waste waters can be scrubbed free of sulphur compounds. Waste solids such as spent dolomite may present disposal problems in terms of available space and/or surface water contamination, but these are not insurmountable problems.
3. Noise will occur from mechanical equipment, injectors, and pressure-reduction devices, but it is unlikely that it would be a problem beyond the plant property lines.

To illustrate the order of magnitude of the major emissions that would have to be handled from a commercial coal-to-pipeline gas plant, the FPC's National Gas Survey gave the following estimates, based on a plant producing 250 million standard cubic feet per day of pipeline gas 1/ from coal with 3.7 percent sulphur:

	<u>tons per day</u>
Sulphur (mainly as hydrogen sulphide)	300-400
Ammonia	100-150
Phenols	10-70
Benzene	50-30

1/ This size SNG plant produces the equivalent of 40,000 bbls per day of crude petroleum.

Oil and Tars

tons per day

trace to 400

Ash (based on coal with 10% ash)

1500

The Federal Power Commission report describes in detail the general means for controlling contaminants in the process waste waters, and the various gas streams.

References

Coal Gasification

Federal Power Commission, National Gas Survey, Synthetic Gas-Coal Task Force. Environmental Considerations in Coal Gasification Plants.

Forney, A. J., Kennety, R. F., Field, J. H., 1968, Fluid-Bed Gasification of Pittsburg-Seam Coal with Oxygen and with Air, Preprints, Division of Fuel Chemistry, Am. Chem. Soc., Vol. 12, No. 3, pp. 32-42.

Forney, A. J., Katell, S., Crentz, W. L., 1970a, High-B. t. u. Gas from Coal Via Gasification and Catalytic Methanation, Proceedings, American Power Conference, Vol. 32, pp. 428-434.

Forney, A. J., Gasior, S. J., Maynes, W. P., Katell, S., 1970b, A Process to make High-B t. u. Gas from Coal, Bu. Mines Tech. Prog. Rep. 24, April, p.6.

Hottel, J. C., and others, 1971, New Energy Technology--Some Facts and Assessments, the MIT Press, Cambridge, Massachusetts.

Mills, G. Alex, 1970, Progress in Gasification--U. S. Bureau of Mines Presented, Third Synthetic Pipeline Gas Symposium, Am. Gas Assoc., Chicago, Illinois, November.

Mills, G. Alex, et. al., 1971, Fuel Management in an Environmental Age, Environmental Science and Technology, Vol. 5, January, pp. 30-38.

Office of Coal Research, Annual Report, 1972.

Oil Gasification

Cockerham, R. G., Percival, G., and Yarwood, T., The Catalytic Gasification of Petroleum Feedstocks, Research Communication GC 106, The Gas Council, (England), 1965.

Milner, J. J., Some Recent Developments in the Production of Rich Gas from Liquid Hydrocarbons, presented before the American Gas Association, Inc., Production Conference, Buffalo, New York, May 24, 1965.

Office of Coal Research, Annual Report, 1972.

Schultz, E. B., Linden, H. R., High-Pressure Hydrogasification of Petroleum Oils, Research Bulletin No. 29, Institute of Gas Technology, Chicago, Illinois, 1960.

Taylor, A. S., and Milner, G., Some Methods of Making Gas From Oil, paper presented to The Institute of Gas Engineers (England), March 1958.

Thompson, B. H., Majumdar, B. B. M and Conway, H. L., The Hydrogenation of Oils to Gaseous Hydrocarbons, Research Communication GC 122, The Gas Council (England), 1966.

Thompson, B. H., Majumdar, B. B., and Conway, H. L., Synthetic Natural Gas Can Boost Gas Supplies, The Oil and Gas Journal, September 13, 1971, pp. 78-79.

11. Energy Conservation

If demand for energy could be reduced sufficiently, the projected oil and gas production from the proposed lease sale would be unnecessary. However, it is a misleading simplification to view the choices as either (1) producing 5-11 thousand barrels of oil and 750-1050 million cubic feet of gas per day from the OCS leases or (2) reducing demand for energy by this amount. Several considerations invalidate this seemingly logical reasoning: the widening gap between demand and supply of energy from all sources in the near future, the immediate shortage of natural gas, and the limitations from the point of view of technology, cost, and time lag on substitution of other energy sources for oil and gas.

The shortage of natural gas is already evident. FPC estimates that demand for natural gas will exceed supply from all sources (including LNG, coal gas, and pipeline imports) by 3.6 trillion cubic feet in 1975, 9.5 trillion cubic feet in 1980, and 13.7 trillion cubic feet in 1985. The projected production from the lease sale of 750-1050 million cubic feet/day, or 274-383 billion cubic feet a year, is equivalent to only 3.8% to 6.9% of estimated 1980 unsatisfied demand. Thus, only by reducing demand for natural gas by an amount greatly exceeding the projected lease production would such production be unnecessary.

The demand for energy in the U. S. has been increasing at an average rate of 3.1% annually for the last twenty years, more than twice the growth rate of U. S. population. The United States has both the highest per capita consumption of energy and the highest per capita income in the world. Standard of living and GNP have been correlated to energy consumption. Continued increases in material standard of living tend to be equated with increased number, variety, and size of objects which consume energy in their construction and operation: automobiles, aircraft, refrigerators, air conditioners and the like. In the past, energy growth has been little constrained by price or by supply of resources. However, uncertainty of long-term energy supplies, recognition that environmental costs should be reflected in the price of energy, and concern over environmental quality will affect future energy use.

One approach to reduction in growth of energy demand is reduction in population growth. The association between rapid population growth and rapid economic expansion is no longer valid. The Commission on Population Growth and the American Future states: "We have looked for, and have not found any convincing economic argument for continued national population growth. The average person will be markedly better off in terms of traditional economic values if population growth follows the two-child projection rather than the three-child one." ^{1/} (Two children per woman approximates long-term Zero Population Growth fertility rate).

^{1/} Commission on Population Growth and the American Future, Population and the American Future, March, 1972.

U. S. population growth is in a transitional phase and appears to be declining. Population in 1970 was 204 million. Even if family size drops to a two-child average, population will continue to grow, reaching 271 million by 2000. The three-child family would bring the population to 322 million, or 51 million more than the two-child family over the next three decades. 1/

In the short term, reduction in population growth will do little to reduce growth in energy consumption. In a study of electricity demand, alternative population projections showed that "the population assumption is unimportant for demand growth in the next 20 to 30 years". 2/ In addition, the most important factor in growth of energy demand has not been population but higher energy use per capita.

The most promising approach to reduction in demand is therefore through lower per capita use of energy. The rate of growth of per capita energy demand could be reduced by (1) reducing the rate of growth of demand for the goods and services produced with energy, (2) producing the demanded goods and services more efficiently, and (3) converting energy to useful work more efficiently. Sectors with great potential for energy savings are residential space heating and cooling and transportation.

1/ Ibid.

2/ Duane Chapman, Timothy Tyrrel, Timothy Mount, Electricity Demand Growth: Implications for Research and Development, June, 1972.

Economics in energy consumption could be realized in space heating and cooling. Electrical power generation is only about 35% efficient and another 10% of generated power is lost in transmission. In contrast, oil fired home furnaces are about 65% to 85% efficient in generating heat. Better insulation could further reduce fuel consumption in homes. Solar heating and heat pumps for home heating require research and development but offer promising possibilities.

A step forward was taken in 1971 with the revision of the Federal Housing Authority's Minimum Property Standards (MPS) for single family dwellings. The MPS establishes thermal design criteria for qualification of residences for FHA-insured mortgages. However, new homes constructed through conventional financing are not required to follow these standards. A study of construction practices found that appreciable energy savings were possible through better insulation. The revised FHA-MPS do not distinguish between electrically heated and combustion heated homes. Consequently, the potential electricity saving afforded by the revised Standards is only 30% of the saving afforded by the economically optimum insulation in the southern region where electric heat is most popular and only 40% in the central region. Additional insulation would afford further energy savings. 1/

1/ John C. Moyers, The Value of Thermal Insulation in Residential Construction: Economics and the Conservation of Energy, Oak Ridge National Laboratory, December, 1971.

The National Wood Insulation Association also projects energy savings by thermal treatment of residences. Two approaches are examined: a "total participation" program and a "reasonably attainable" program. Without better thermal treatment, energy usage for residential space conditioning over the next ten years is estimated at 96,500 trillion Btu's. The reasonably attainable program would cut this amount by 8.5%, the total program by 15.9%.

The Office of Emergency Preparedness estimates that by 1980 space heating and cooling requirements could be reduced by 30% through improved insulation and a nationwide education program to encourage conservation practices in the home. 1/ Thermal insulation also reduces the energy required for air conditioning, an important factor in summer peak loads of utility systems. Different models of air conditioners vary greatly in efficiency. The least efficient consumes 2.6 times the electricity consumed by the most efficient to provide the same cooling. If more efficient air conditioners were used, the annual power consumption for air conditioning in 1970 could have been reduced by 15.8 billion Kwh, or about 40%. The connected load would have also been decreased by 40%, or by 17,800 MW. 2/

1/ Energy Conservation, July, 1972.

2/ Eric Hurst and John C. Moyers, Improving Efficiency of Energy Use: Transportation and Space Heating and Cooling, written testimony submitted to the House Subcommittee on Science, Research and Development, June, 1972.

Substantial reductions are also possible in the transportation sector. The transportation of people and goods comprised 24.5% of U. S. energy consumption in 1970. Increases in transportation energy consumption are due primarily to growth in levels of traffic and shifts to less energy efficient modes. The following tables show energy requirements for transport of freight and passengers. 1/ The efficiencies are typical of the mid-1960's.

Freight Transport Btu/ton mile		Passenger Transport Btu/passenger-mile	
Pipeline	450	Bicycle	200
Waterway	540	Walking	300
Railroad	680	Buses	1,200
Truck	2,300	Railroads	1,700
Airplane	37,000	Automobile	4,500
		Airplane	9,700

The shift from railroads to truck and airplane in freight traffic and from railroad and buses to airplanes has caused declining energy efficiency. The trend is encouraged by preferential government policies favoring air and highway transport. Low average car occupancy, use of cars for many short trips, and disregard for congestion problems increase fuel consumption and pollution.

1/ Eric Hurst, Energy Consumption for Transportation in the U. S., Oak Ridge National Laboratory, June, 1971.

In order to illustrate possible energy savings through use of energy efficient transport modes, one study devised a hypothetical, entirely speculative model which required only 71% as much energy as that actually expended in 1970 to move the same traffic. Although this model ignored factors that inhibit shifts to energy-efficient modes, it shows the magnitude of reduction that is possible. 1/

A report by the Office of Emergency Preparedness 2/ estimated that short-term measures could produce a maximum energy savings in the transportation sector of 1.9 quadrillion Btu per year by 1975, equal to 10% of transportation demand. Such measures would include educational programs, establishment of government efficiency standards, improved airplane load factors, smaller engines and vehicles, improved mass transit, and improved traffic flow. Public awareness of energy conservation and alternatives would foster a clearer understanding of the energy implications of decisions. A change in public attitudes toward walking, bicycling, and mass transit, might do much to reduce demand for energy.

1/ Improving Efficiency of Energy Use: Transportation and Space Heating and Cooling, op.cit.

2/ Executive Office of the President, Office of Emergency Preparedness, Energy Conservation, July, 1972.

With the exception of the primary metals sector, industrial demand for energy under existing technology could be reduced by 5 to 10% given sufficient economic incentives (possibly price increases or an energy tax). ^{1/} Industrial energy demand can be cut by recycling metals. For non-ferrous metals the amount of energy required to recycle scrap metal is less than 20% of that required to refine the metal originally although new low energy primary metal extraction methods are in development.

Another way to better match supply and demand for energy is through the price mechanism. In the past, use of natural air, water, and land resources has been virtually free. If a price were put on social costs reflecting depletion of resources and damage to the environment, energy would tend to be produced in ways that conserve natural resources. Higher input prices would be passed on as higher output prices, which would reduce demand. This concept underlies such proposals as a tax on auto- emissions, which could be based on number of miles driven and a test on emissions for each vehicle. An auto tax would make it more expensive to drive a car and encourage use of mass transport. In addition, these taxes would provide incentive to develop cleaner technology.

If the costs of environmental and resource use were better reflected in prices of energy, more informed choices could be made. An electric rate schedule including higher charges for peak period usage would

^{1/} Ibid.

encourage consumers to shift use to other times of day, resulting in more efficient use of existing plants and less construction of new generating capacity to service peak demand.

According to one study, 1/ "Substantial cost increases and reduction in population growth will noticeably lower electricity demand growth in the 1980's and 1990's. Given the lengthy time period of response, growth reduction in the 1970's might be limited." The authors give the following preliminary estimates of elasticity of electricity demand for electricity prices, income, population, and gas prices.

1/ Electricity Demand Growth: Implications for Research and Development, op.cit.

Summary of Electricity Demand Estimated Elasticities
for Electricity Prices, Income, Population, and Gas Prices

<u>Factor</u>	<u>Residential</u>	<u>Consumer Class</u>	
		<u>Commercial</u>	<u>Industrial</u>
Average Electricity Price	-1.3	-1.5	-1.7
Population	+ .9	+1.0	+1.1
Income	+ .3	+ .9	+ .5
Average Gas Price	+ .15	+ .15	+ .15
Percent of Response in First Year	10%	11%	11%
Years for 50% of Total Response	8 years	7 years	7 years

The elasticities of demand represent the relationship of the percentage change in electricity demand and the percentage change in the factor.

For example, the commercial elasticity for electricity prices of -1.5 means that a 20% rise in average commercial electricity price would in the long run cause demand to be 30% less than it otherwise would have been.

The kind of public policies that would be required to reduce demand, according to Michael McCloskey, Executive Director of the Sierra Club, would include the replacement of the market system to determine how much energy shall be produced or imported and who shall consume energy, with a detailed control on the production, importation, and use of energy in all sectors and regions of the economy. In his

evaluations relative to controlling energy growth, he states:

"A short-run strategy would involve the following changes in public policy: ending or reducing the many biases in public policies which provide incentives to energy growth; maintaining and strengthening environmental constraints on energy growth; reducing energy demands by educating the public to understand the importance of conservative use of energy; encouraging intensified research and development in order to achieve greater efficiencies in energy utilization and in order to find new, more environmentally acceptable energy sources and discouraging growth in industries that are the most profligate consumers of energy. Coordination of these efforts would be facilitated through the establishment of new government agencies, specifically geared to respond to the energy problem. Each of these changes would involve efforts that would go well beyond the traditional bounds of energy policy, and all could have profound economic and social impacts. Yet changes are already beginning to occur in all these fields, and environmentalists are determined to promote them." 1/

1/ Michael McCloskey, "The Energy Crisis: The Issues and a Proposed Response", Environmental Affairs, Vol. 1, No. 3, Nov. 1971, pp. 587-605.

The proposed OCS lease sale is projected to supply approximately 750 to 1050 million cf/d of natural gas by 1985. An evaluation of reduction in demand for natural gas must take into account the present acute shortage of supply. Demand for natural gas is already under restraint due to a variety of controls, including regulatory limitations on new sales (including residential and commercial sales), voluntary restrictions on new sales adopted by gas companies, and the economic restraints inherent in rising retail prices for natural gas. Furthermore, the emphasis being placed on improving air quality is increasing the demand for natural gas because its exhaust contains no sulfur and no particulates. The expected natural gas production from this lease sale would not cause any growth or change in existing patterns of gas consumption. Several pipelines supplied by offshore Louisiana wells have been forced to curtail activities below contracted quantities by amounts in excess of the expected production of natural gas from the lease sale.

If a reduction in demand were directed at the oil and natural gas to be developed from the proposed OCS oil and gas lease sale, all the environmental impacts associated with that development and energy use would be eliminated as a result of the direct tradeoff. It would also eliminate any environmental damages and any adverse results associated with any one of the alternatives to the sale.

A major consideration in restricting demand for energy resources is that the cost involved in such a restriction is not related to the environmental damage which would be prevented by not producing, transporting and consuming the energy resources involved. In the case where pollution standards are introduced and enforced, causing the amount of environmental damage to the air per unit of energy produced to decrease radically over the period of a few years, the environmental benefits of the action decline but the associated costs do not.

The following table shows the trend in quantities of air pollutants emitted from mobile equipment using petroleum products. ^{1/}

Estimated Emissions From Mobile Equipment
(millions of tons per year)

	<u>1965</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>	<u>1985</u>
Hydrocarbons					
Autos	13.0	11.0	5.9	2.4	0.9
Trucks and buses	1.7	1.9	1.7	1.4	1.4
Aircraft	.2	.3	.2	.1	.1
Off-highway	.7	.6	.6	.6	.5
Total	<u>15.6</u>	<u>13.8</u>	<u>8.4</u>	<u>4.5</u>	<u>2.9</u>
Carbon monoxide					
Autos	55.2	54.3	40.6	24.3	12.7
Trucks & buses	15.6	17.4	16.2	14.0	14.2
Aircraft	.9	.4	.5	.7	.8
Off-highway	5.7	5.3	5.5	4.4	3.4
Total	<u>77.4</u>	<u>77.4</u>	<u>62.8</u>	<u>43.3</u>	<u>31.1</u>
Nitrogen oxide					
Autos	4.8	5.7	5.0	2.8	1.3
Trucks & buses	1.1	1.4	1.6	1.5	1.7
Aircraft	.03	.05	.06	.08	.09
Off-highway	.9	.9	.9	1.1	1.1
Total	<u>6.8</u>	<u>8.1</u>	<u>7.6</u>	<u>5.5</u>	<u>4.2</u>
Particulate					
Autos	.2	.3	.3	.2	.1
Trucks & buses	.1	.2	.2	.2	.2
Aircraft	.02	.04	.04	.04	.05
Off-highway	.2	.2	.2	.2	.1
Total	<u>.5</u>	<u>.7</u>	<u>.7</u>	<u>.6</u>	<u>.5</u>

The impact of the stricter 1968 air pollution standards is quite apparent.

^{1/} National Petroleum Council (NPC), Environmental Conservation, The Oil and Gas Industry, v. 2, p. 308, February, 1972.

Interpretation of this table shows that an equal reduction in energy demand in 1970 and in 1985 would be more costly in 1985, in terms of energy sacrificed per unit of pollution avoided.

Research and development of more efficient methods of energy extraction and use offer long range possibilities for reduction in the amount of input needed to produce a given energy output. In this regard efforts should be directed toward development of total energy processes through which, for example, waste heat discharges could be used to run turbines, for preheating, drying and space heating. Other promising research areas include fuel cells, magnetohydrodynamics, and breeder reactors.

A comprehensive study of energy conservation has just been released by the Office of Emergency Preparedness. 1/ The study considers only user conservation and not improvements in recovery techniques or related government actions. If all the suggested measures are implemented, potential annual energy savings by 1980 could be the equivalent of a total of 7.3 million barrels/day of oil; 2.4 million barrels/day in the residential/commercial sector, 2.3 million barrels/day in the transportation sector, and 2.6 million barrels/day in the industrial sector. It is significant to note the study's conclusion

1/ Energy Conservation, op. cit.

that "while the conservation measures proposed in this report will not, taken alone, eliminate the need for increased oil imports, they can substantially reduce this need." Efforts to reduce demand and develop domestic energy resources must be carried forward together.

12. Combinations of Alternatives

In the interest of clarity of presentation this analysis has discussed separately each potential alternative form of energy as a possible substitute to the oil and gas anticipated from the proposed sale. It is highly unlikely that there will ever be a single definitive choice to be made between any potential energy form and its alternatives. Each may have a role to play; some may make major contributions to our energy supplies, while others may be subordinated to lesser roles. Some alternatives may be developed rapidly; others may evolve more slowly--perhaps to make a more important contribution at a later date. Predictions made on the basis of present knowledge of the relative roles of these potential alternatives is a highly subjective exercise which must necessarily include a large measure of judgment as to future trends in such variables as the direction and pace of technological development, the identification of usable resources, the rate of natural economic growth and changes in our life style.

The table which follows this section summarizes the pertinent data developed in other sections of this statement as to the possible alternatives to provide the energy equivalent to that projected for the proposed sale. Examination of this table will facilitate consideration of possible combinations of alternatives.

It seems most probable that many of the alternatives outlined in the table will be developed to some degree. Understanding of the extent to which they may replace or complement offshore oil and gas requires reference to the characteristics of our total national energy system. Factors most relevant to the issues at hand are outlined below:

1. Historical relationships indicate that energy requirements will grow at approximately the same rate as gross national product.
2. Energy requirements can be constrained to some degree through the price mechanism in a free market or by more direct constraints. One important type of direct constraint operating to reduce energy requirements is through the substitution of capital investment in lieu of energy; e.g., insulation to save fuel. Other potentials for lower energy use have more far-reaching impacts and may be long range in their implementation--they include rationing, altered transportation modes, and major changes in living conditions and life styles. Even severe constraints on energy use can be expected to only slow, not halt, the growth in energy requirements within the time frame of this statement.
3. Energy sources are not completely interchangeable. Solid fuels cannot be used directly in internal combustion engines;

for example; fuel conversion potentials are severely limited in the short term although somewhat greater flexibility exists in the longer run and generally involves choices in energy-consuming capital goods.

The principal competitive interface between fuels is in electric powerplants. Moreover, the full range of flexibility in energy use is limited by environmental considerations.

4. A broad spectrum of research and development is being directed to energy conversion--more efficient nuclear reactors, coal gasification and liquefaction, liquified natural gas (LNG), and shale retorting, among others. Several of these should assume important roles in supplying future energy requirements, though their future competitive relationship is not yet predictable.
5. Major potentials for filling the supply/demand imbalance for domestic resources are:
 - More efficient use of energy
 - Environmentally acceptable systems which will permit production and use of larger volumes of domestic coal.
 - Accelerated exploration and development of all domestic oil and gas resources.
 - Development of the Nation's oil shale resources.

Of the foregoing, increased domestic oil and gas production offers considerable possibilities, since indicated and undiscovered domestic resources total some 417 billion barrels of oil and 2,100 trillion cu.ft. of gas which are estimated to be producible under current technology. However, the feasibility of providing adequate incentive and reducing the uncertainties inherent in petroleum exploration is not known.

6. The acceptability of oil and gas imports as an alternative is diminished by:
 - A narrowing gap between costs of foreign and domestic oil.
 - Apparent high costs of liquefying and transporting natural gas other than overland by pipeline.
 - The security risks inherent in placing reliance for essential energy supplies on sources which have demonstrated themselves to be politically unstable and prone to use interruption of petroleum supplies to exert economic and political pressure on their customers.
 - The aggravation of unfavorable international trade and payments balances which would accompany substantial increases in oil and gas imports.

Though this section considered the possibility of combinations of alternatives, in view of the foregoing it seems reasonable to postulate that for some time to come the basic alternative to the production of the oil and gas from the sale would be an

equivalent amount of foreign imports. This would be true whether it is considered as an alternative to the entire proposed sale or to any number of tracts deleted from the sale. The problems associated with this alternative have been discussed in the text. Although an equivalent amount of imports appears the basic alternative for the foreseeable future (ten to fifteen years), it is difficult to predict what alternatives, or combinations of alternatives, would be feasible in the more distant future. The availability of other alternatives in the more distant future is discussed elsewhere in the text.

Incremental Production Potential of Proposed
Lease Sale and Alternatives

<u>Alternative</u>	<u>Production Potential</u>			
	<u>1980</u>		<u>1985</u>	
	<u>Physical Units</u>	<u>Btu (billions)</u>	<u>Physical Units</u>	<u>Btu (billions)</u>
Proposed sale				
Oil	5-11/kbbl.	30-60	5-11/Kbbl.	30-60
Gas	750-1050/Mcf/d	775-1100	750-1050 Mcf/d	775-1100
Imports				
Mid-East oil	5-11/Kbbl.	30-60	5-11/Kbbl.	30-60
LNG	750-1050/Mcf/d	775-1100	750-1050/Mcf/d	775-1100
Onshore Production				
Economic Incentives	5-11/Kbbl.	30-60	5-11/Kbbl.	30-60
North Slope <u>1/</u>	None		None	
Expl. Fracturing <u>2/</u>	8200/Mcf/d	8500	8200 Mcf/d	3500
Nuclear Power	24,000 MW	1,000	24,000 MW	1000
Coal as Solid Fuel	38,700/t.	1,000	87,000/t	1000
Hydroelectric	None		None	
Natural Gas Pricing <u>3/</u>	Uncertain		Uncertain	
Oil Shale	300/Kbbl.	200	1000/Kbbl/d	5800
Synthetic Gas				
Coal	970/Mcf/d	1000	970/Mcf/d	1000

1/ Alaskan oil is not likely to flow before 1976 in subsequent years it will meet deficits in West Coast Markets rather than markets served by this sale.

2/ Assuming recovery at 1% of additional recoverable reserves per year.

3/ Gas production might be stimulated to produce production equal to that of the proposed sale although gas can not fully substitute for oil.

C. Delay Sale Until New Technology is Available to
Provide Increased Environmental Protection

The sale could be delayed until new technology is available; however, basically safe technology is available provided its application and use are properly regulated and controlled. As new technology relating to safety and environmental protection is developed, it can be incorporated with existing requirements and applied to all OCS leases so that bringing on additional production now will not generally preclude adaptation of new advances to the prospective leases. "Zero risk" does not exist but is an ideal toward which safety systems are directed. In the history of Federal offshore leasing and production over the past 18 years only 10 significant oil spills have occurred in more than 1,500 leases, 10,500 drilling holes, and 1,935 producing platforms.

In addition, the proposed sale could be delayed pending completion of all studies concerning the potential environmental impacts of offshore minerals development in general and oil spills specifically. There are many studies relating to these issues being conducted by the scientific community and industry as well as the government that are of a long-term, ongoing nature. The Bureau of Land Management is initiating long-term, ongoing studies of its own both on an inhouse and contract

basis. A central feature of many of these studies is that they are never really completed in the sense that they rarely reach definite conclusions with wide applicability, but simply advance from one stage to another, from one level of analysis to another, thereby contributing to a growing area of knowledge and body of literature pertaining to the numerous complexities of environmental analysis. To delay the sale on the basis of incompleted studies would require an indefinite delay perhaps of many years duration and would tend to discount information which is already known. Undoubtedly, information gaps and uncertainties will always be associated with offshore minerals development and any delays in such a development program must be judged on the basis of whether or not these gaps and uncertainties are so great, compared with what is known, as to warrant postponement. Moreover, the President, in his Clean Energy Message, called for an accelerated OCS leasing program as one measure to help make available energy resources of Federal lands for national energy needs. Final judgment then must rest on a determination regarding whether or not a delay at this time would be in the nation's best interest.

IX. CONSULTATION AND COORDINATION WITH OTHERS

A. Federal

In preparation of the Draft Environmental Statement review comments have been solicited from appropriate Bureaus and offices within the Department of the Interior. In addition, the Environmental Protection Agency, the Department of Commerce, Department of Transportation, Atomic Energy Commission, Federal Power Commission and the Office of Emergency Preparedness have been consulted throughout the preparation phase of the environmental statement.

B. State

In the preparation of the Draft Environmental Statement, advice was solicited from the appropriate offices of the State of Louisiana and Texas.

C. Public

A public hearing concerning this proposed sale to be held in Houston, Texas has been tentatively scheduled for sometime in February, 1973.

ATTACHMENTS

TENTATIVE SCHEDULE — OCS LEASING

June 1971

[illegible]

*This schedule is subject to annual revision

ATTACHMENT BPROPOSED GENERAL SALE

<u>Area</u>	<u>Approx. Water Depth (Feet)</u>	<u>Approx. Distance From Shore* (Statute Miles)</u>	<u>Acreage</u>	<u>Primary Production Anticipated</u>
<u>Galveston Area</u>				
Block 190 (E 1/2)	50	13	2880	Oil
211 (N 1/2)	55	14	2880	"
212 (N 1/2)	55	12	2880	"
325	75	28	5760	Oil and Gas
326	75	27	5760	"
381	80	20	5760	"
382	90	23	5760	"
392 (N 1/2)	90	24	2880	"
393 (N 1/2)	90	22	2880	"
 <u>Galveston Area - South Addition</u>				
Block A123	155	55	5760	Gas
A124	160	57	5760	"
A130	155	65	5760	"
A131	160	63	5760	"
A133	165	59	5760	"
A134	165	57	5760	"
A135	170	55	5760	"
A152	170	58	5760	"
A153	170	60	5760	"
A154	170	62	5760	"
A156	180	65	5760	"
A157	185	67	5760	"
A163	170	63	5760	"
A164	160	62	5760	"
A165	175	60	5760	"
A166	180	59	5760	"
A181	205	61	5760	"
A182	190	63	5760	"
A183	205	64	5760	"
A184	205	66	5760	"
A198	240	61	5760	"
A199	230	59	5760	"
A208	265	62	5760	"
A209	270	63	5760	"

* Measured to the center of the tract

<u>Area</u>	<u>Approx. Water Depth (Feet)</u>	<u>Approx. Distance From Shore* (Statute Miles)</u>	<u>Acreage</u>	<u>Primary Production Anticipated</u>
High Island Area				
Block 92	45	17	5760	Gas
110	45	18	5760	"
111	45	20	5760	"
141 (W 1/2)	50	17	2880	"
142	50	16	5760	"
154 (N 1/2)	50	18	2880	"
200	30	32	5760	"
High Island Area - South Addition				
Block A442	170	80	5760	"
A446	165	78	5760	"
A447	160	76	5760	"
A448	160	74	5760	"
A457	145	65	5760	"
A463	165	77	5760	"
A464	170	78	5760	"
A465	175	80	5760	"
A474	170	79	5760	"
A475	165	78	5760	"
A480	155	67	5760	"
A481	150	65	5760	"
A482	160	67	5760	"
A483	165	69	5760	"
A488	175	79	5760	"
A489	175	81	5760	"
A495	220	93	5760	"
A496	220	91	5760	"
A502	180	80	5760	"
A513	190	81	5760	"
A518	210	92	5760	"
A519	215	93	5760	"
A520	225	95	5760	"
A521	235	97	5760	"
A532	185	75	5760	"
A533	185	74	5760	"
A534	180	76	5760	"
A535	195	78	5760	"
A555	275	86	5760	"

* Measured to the center of the tract

<u>Area</u>	<u>Approx. Water Depth (Feet)</u>	<u>Approx. Distance From Shore* (Statute Miles)</u>	<u>Acreage</u>	<u>Primary Production Anticipated</u>
High Island Area				
<u>South Addition (cont')</u>				
Block A556	245	84	5760	Gas
A558	210	80	5760	"
A559	210	78	5760	"
A563	315	86	5760	"
A564	305	88	5760	"
A570	280	102	5760	"
A571	280	104	5760	"
A572	295	105	5760	"
A573	330	107	5760	"
High Island Area -				
<u>East Addition</u>				
Block 46	20	17	5760	"
High Island Area				
<u>East Addition - South Extension</u>				
Block A262	150	85	5760	"
A263	150	84	5760	"
A272	160	88	5760	"
A273	160	88	5760	"
A274	160	89	5760	"
A275	165	89	2911	"
A276	180	92	4350	"
A277	175	92	5760	"
A278	180	91	5760	"
A279	175	90	5760	"
A283	170	83	5760	"
A298	195	94	5760	"
A299	195	92	5760	"
A304	210	94	5760	"
A305	205	96	5760	"
A312	210	104	5760	"
A313	210	104	5760	"
A314	210	102	5760	"
A317	215	96	5760	"
A322	235	98	5760	"
A323	225	100	5760	"
A324	220	102	5760	"

* Measured to the center of the tract

<u>Area</u>	<u>Approx. Water Depth (Feet)</u>	<u>Approx. Distance From Shore* (Statute Miles)</u>	<u>Acreage</u>	<u>Primary Production Anticipated</u>
High Island Area -				
<u>East Addition - South Extension (cont')</u>				
Block A325	215	104	5760	Gas
A326	225	106	5760	"
A327	220	107	5760	"
A328	210	108	2880	"
A329	185	108	2907	"
A330	270	111	4346	"
A331	250	111	2880	"
A332	230	110	5760	"
A333	220	109	5760	"
A334	220	106	5760	"
A336	235	102	5760	"
A337	235	100	5760	"
A340	205	99	5760	"
A341	245	101	5760	"
A350	295	117	4345	"
A351	290	116	5760	"
A358	240	104	5760	"
A359	200	102	5760	"
A360	250	104	5760	"
A361	275	106	5760	"
A368	335	119	5760	"
A369	360	120	2880	"
A370	390	120	2904	"
West Cameron Area -				
<u>South Addition</u>				
Block 528	175	90	5000	"
586	235	110	5000	"
595	250	113	5000	"
East Cameron Area -				
<u>South Addition</u>				
Block 269	160	78	5000	"
335	270	104	5000	"

*Measured to the center of the tract

G E O L O G I C T I M E C H A R T 1/

AGE DIVISIONS			TIME				
ERA	PERIOD		DURATION IN MILLIONS OF YEARS		BEGINNING MILLIONS OF YEARS AGO		
		EPOCH	ERA	PERIOD			
CENOZOIC	QUATERNARY	RECENT	63.011	1.011	0.011	0.011	
		PLEISTOCENE			2	2	
	TERTIARY	PLIOCENE		62		12	13
		MIOCENE				12	25
		OLIGOCENE				11	36
		EOCENE				22	58
		PALEOCENE				5	63
MESOZOIC	CRETACEOUS	167		72	135		
	JURASSIC			46	181		
	TRIASSIC			49	230		
PALEOZOIC	PERMIAN	370		50	280		
	PENNSYLVANIAN			40	320		
	MISSISSIPPIAN			25	345		
	DEVONIAN			60	405		
	SILURIAN			20	425		
	ORDOVICIAN			75	500		
	CAMBRIAN			100	600		
PRE-CAMBRIAN	GRENVILLE OROGENY	4000			1000		
	OLDEST KNOWN ROCKS IN NORTH AMERICA				3200		
	OLDEST KNOWN ROCKS (MURMANSK AREA)				3400		
	PROBABLE AGE OF THE EARTH				4600		

1/ Adapted from State of Oregon, Department of Geology and Mineral Industries.

Attachment D

Summary

Recreation and Fish and Wildlife
Areas Along the Gulf of
Mexico Coast-Louisiana and Texas

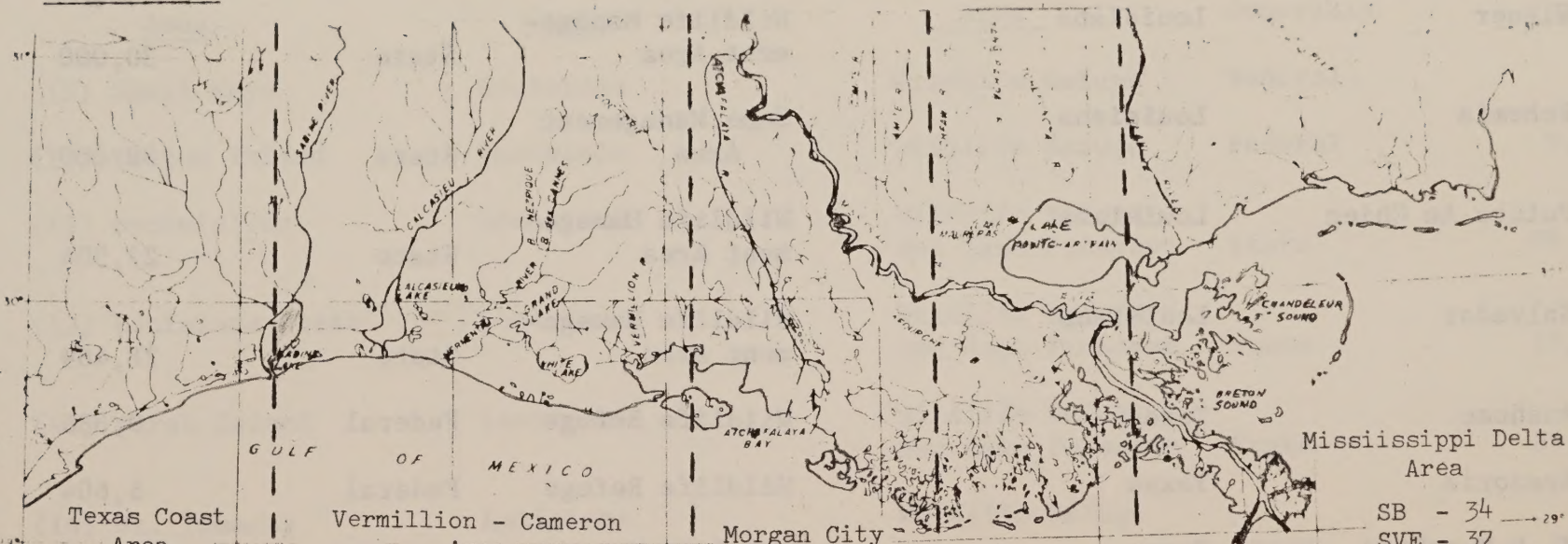
<u>Area</u>	<u>State</u>	<u>Type of Area</u>	<u>Ownership</u>	<u>Acreage</u>
(1) Chandeleur Island	Louisiana	Recreation	State	4,420
(2) Grande Isle	Louisiana	Recreation	State and private	1,000 (126 - State)
(3) Fontenbleau State Park	Louisiana	Recreation	State	2,755
(4) Fort Pike State Park	Louisiana	Recreation	State	125
(5) Fort McComb State Park	Louisiana	Recreation	State	20
(6) Sabine	Louisiana	Wildlife Refuge	Federal	142,845
(7) Lacassine	Louisiana	Wildlife Refuge	Federal	31,776
(8) Delta	Louisiana	Wildlife Refuge	Federal	48,799

<u>Area</u>	<u>State</u>	<u>Type of Area</u>	<u>Ownership</u>	<u>Acreage</u>
(9) Shell Keys	Louisiana	Wildlife Refuge	Federal	8
(10) Breton Island	Louisiana	Wildlife Refuge	Federal	9,047
(11) Rockefeller	Louisiana	Wildlife Refuge and Game Preserve	State	86,000
(12) Louisiana State	Louisiana	Wildlife Refuge and Game Preserve	State	15,000
(13) Marsh Island	Louisiana	Wildlife Refuge and Game Preserve	State	83,000
(14) St. Tammany	Louisiana	Wildlife Refuge	State	1,310
(15) Paul J. Rainey	Louisiana	Wildlife Refuge and Game Preserve	Private	29,000
(16) Bonne Carre	Louisiana	Game Management Area	State	3,789
(17) Biloxi	Louisiana	Wildlife Manage- ment Area	State	39,728
(18) Pass-A-Loutre	Louisiana	Game and Fish Pre- serve State Hunt- ing Ground	State	66,000

<u>Area</u>	<u>State</u>	<u>Type of Area</u>	<u>Ownership</u>	<u>Acreage</u>
(19) Wisner	Louisiana	Wildlife Management Area	State	30,000
(20) Bohemia	Louisiana	Game Management Area	State	30,000
(21) Pointe Au Chien	Louisiana	Wildlife Management Area	State	27,504
(22) Salvador	Louisiana	Wildlife Management Area	State	28,469
(23) Anahuac	Texas	Wildlife Refuge	Federal	9,836
(24) Brazoria	Texas	Wildlife Refuge	Federal	6,604
(25) J. D. Murphree	Texas	Wildlife Management Area	State	8,403
(26) Aransas	Texas	Wildlife Refuge	Federal	54,829
(27) Laguna Atascosa	Texas	Wildlife Refuge	Federal	45,147
(28) San Bernard	Texas	Wildlife Refuge	Federal	14,915
(29) Velasco State Park	Texas	Recreation	State	undetermined
(30) Galveston Island State Park	Texas	Recreation	State	1,922
(31) Brazos Island State Park	Texas	Recreation	State	217
(32) Padre Island National Seashore	Texas	Recreation	Federal	237,600

EQUIPMENT AVAILABLE FOR EMERGENCY
OIL SPILL CONTROL AND CLEANUP
IN THE GULF OF MEXICO

ATTACHMENT E



Texas Coast
Area

SB - 18
SVE - 10
SP - 22
H - 9
FWA - 48

Vermillion - Cameron
Area

SB - 28
SVE - 4
SP - 13
H - 8 MC
FWA - 0

Morgan City -
Atchafalaya
Area

SB - 72
SVE - 14
SP - 31
H - 17 MC
FWA - 3 MC
2 LF
5

Grand Isle
La Fourche
Terre Bonne
Area

SB - 25
SVE - 39
SP - 30
H - 6 GI
6 LV
1 HM
1 DL
14
FWA - 1 LV
4 HM
5

Mississippi Delta
Area

SB - 34
SVE - 37
SP - 55
H - 8 VN
5 EM
2 TC
1 NO
16
FWA - 6 NO
4 TC
3 VN
13

Total Area

Spray Equipment - 20

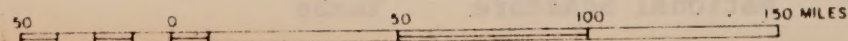
Cities Where Available

MC - Morgan City
CM - Cameron
LF - Lafayette
GI - Grand Isle
LV - Leeville
HM - Houma
DL - Dulac
VN - Venice
EM - Empire
TC - Toca
NO - New Orleans

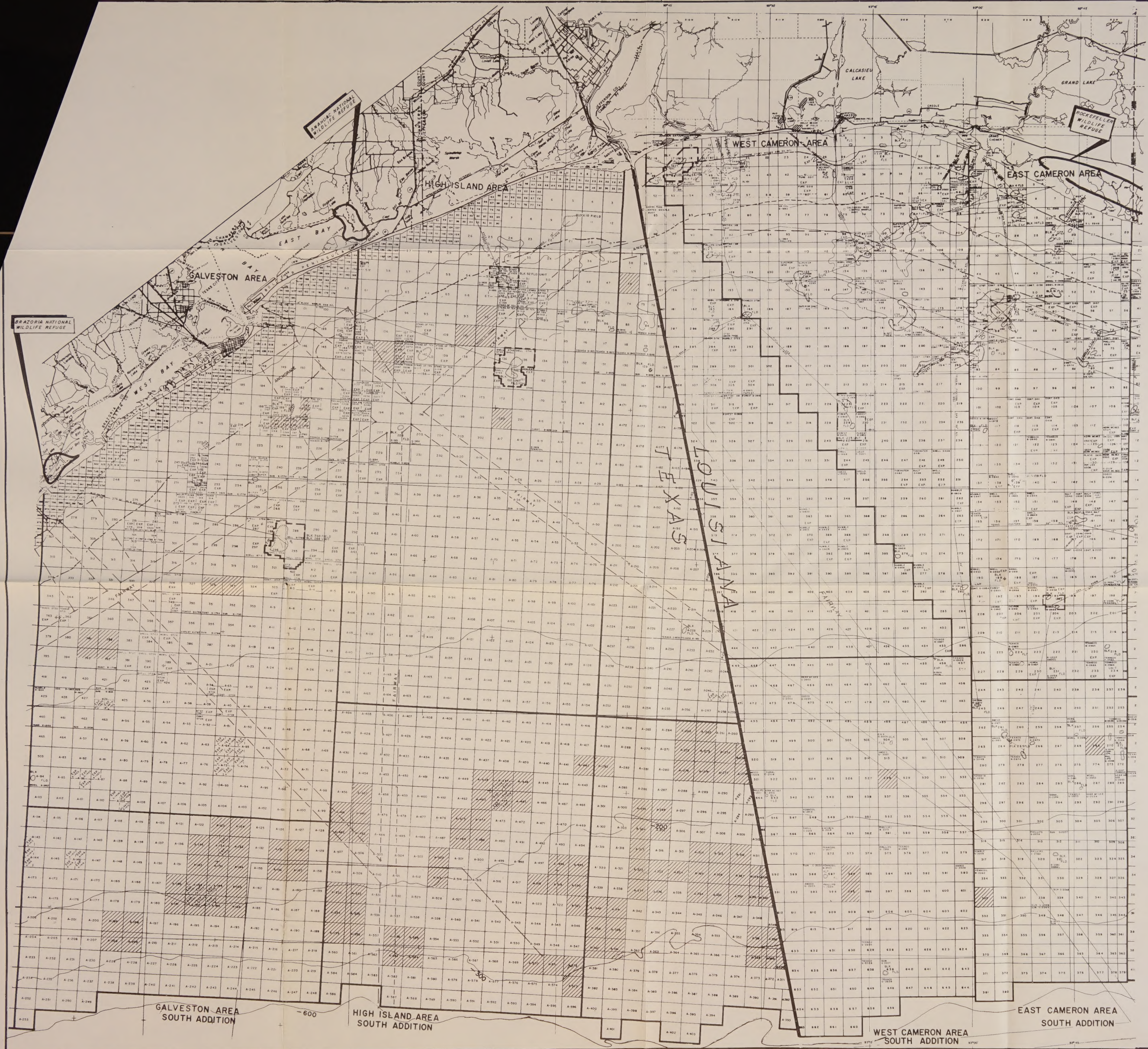
Types of Equipment

SB - Service Boats
SVE - Skimmer & Vacuum Equipment
H - Helicopters
FWA - Fixed Wing Aircraft
SP - Spill Booms

SCALE



BLM Library
Denver Federal
Bldg. 5th, CC-52
P.O. Box 25047
Denver, CO 80225



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
OIL AND GAS LEASING MAP OF THE
GULF COAST
LOUISIANA AND TEXAS
OUTER CONTINENTAL SHELF

JANUARY 1970

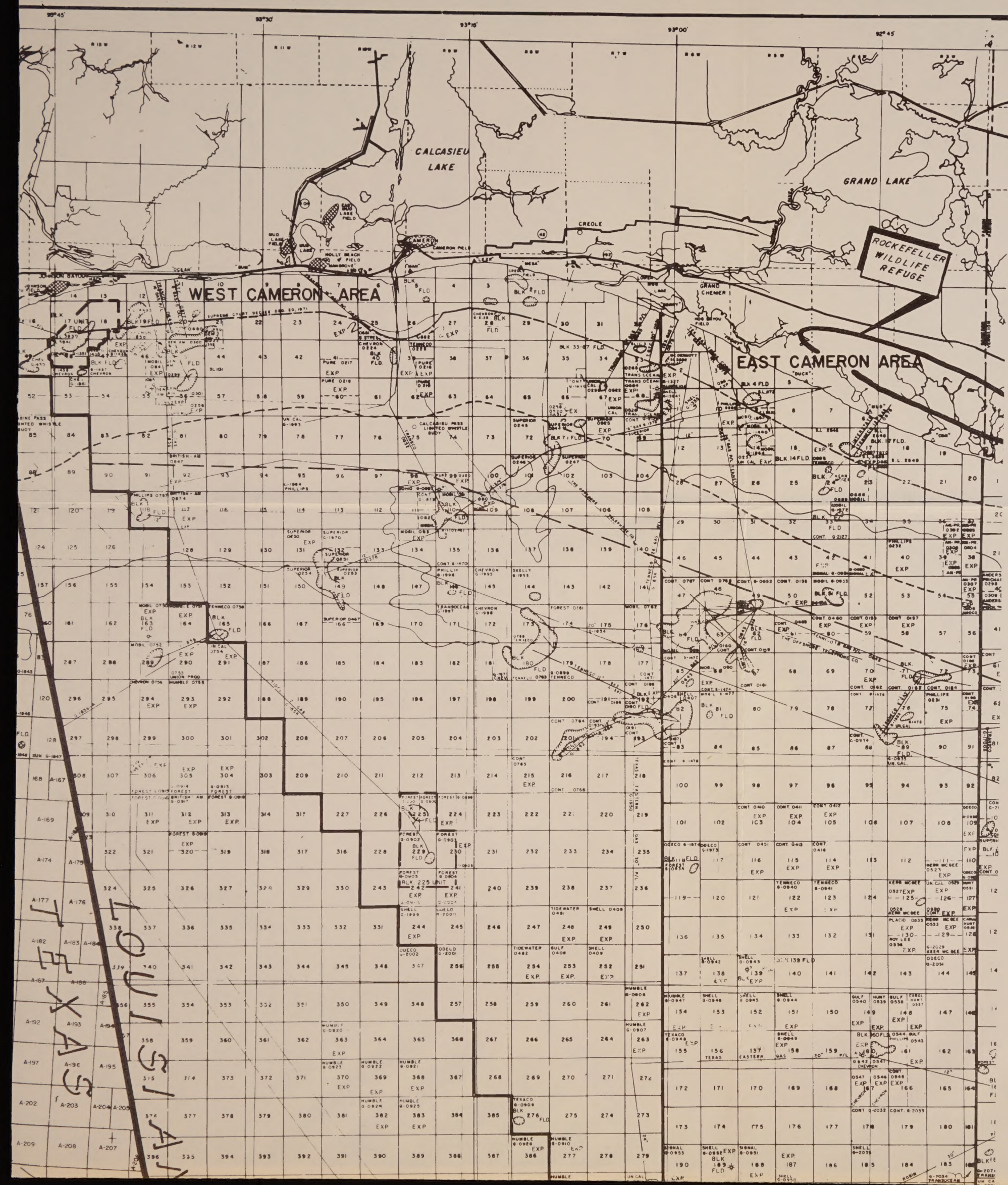
E.F. RIETH

#4785682 ID:98076043 TD195.P4 T494 1973

BRAZORIA NATIONAL
WILDLIFE REFUGE

ANAHUAC NATIONAL
WILDLIFE REFUGE





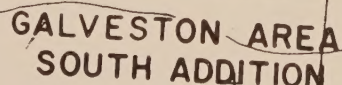
BLM Library

Denver Federal Co.

Bldg. 50, OC-52

P.O. Box 25047

Denver, CO 80225



HIGH ISLAND AREA
SOUTH ADDITION

#4785682

ID: 88076043

TD195.P4 T494 1973:

 TRACTS UNDER CONSIDERATION
FOR POSSIBLE LEASING.

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

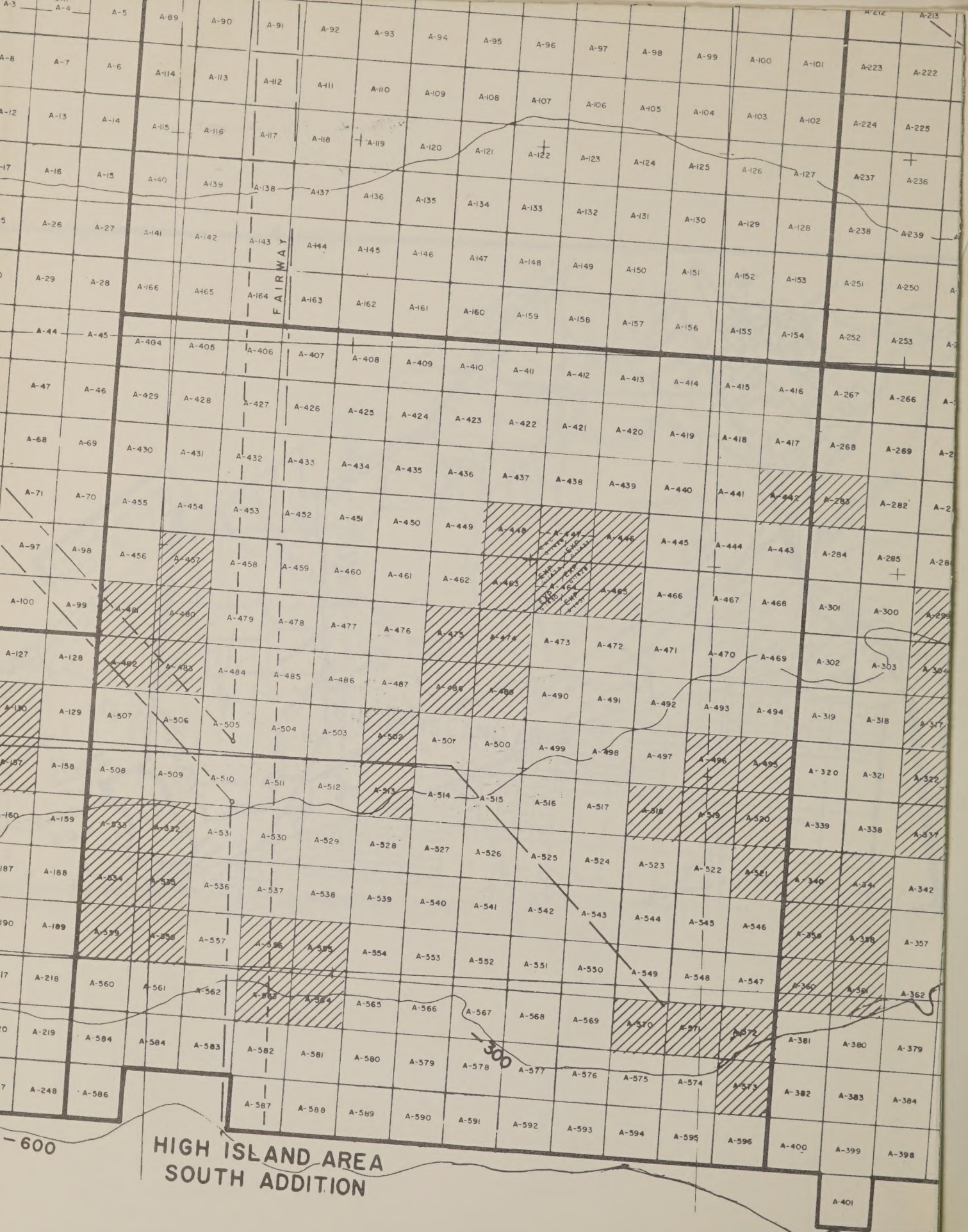
OIL AND GAS LEASING MAP OF THE
GULF COAST
LOUISIANA AND TEXAS
OUTER CONTINENTAL SHELF

JANUARY 1970

EAST CAMERON AREA
SOUTH ADDITION

WEST CAMERON AREA
SOUTH ADDITION

E.F. RIETH



Bureau of Land Management
Library
Denver Service Center

BLM Library
Denver Federal Center
Bldg. 50, OC-521
P.O. Box 25047
Denver, CO 80225

